VOLUME VIII MARCH, 1925 NUMBER 2

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF THE
AMERICAN DAIRY SCIENCE ASSOCIATION

Contents

In Memory of George A. Smith 79
The Trier Compared with the Wedge Method of Sampling Tub Butter—H. B. ELLENBERGER AND E. S. GUTHRIE 80
Yeast as a Supplementary Feed for Lactating Cows—C. H. ECKLES AND V. M. WILLIAMS 89
The Effect of Cane Molasses on the Digestibility of a Complete Ration Fed to Dairy Cows—PAUL S. WILLIAMS 94
Calculating the Average Production of a Dairy Herd—R. B. BECKER 105
Gelatin as a Source of Bacteria in Ice Cream—J. M. BRANNON AND P. H. TRACY 115
The Effect of Season on the Milk and Fat Production of Jersey Cows—C. ELMER WYLIE 127
Treatment of Cream for the Removal of Objectionable Flavors and Odors—O. F. HUNZIKER 132
Relation of Water to Milk Borne Typhoid—CARL R. FELLERS AND ROY S. DEARSTYNE 146
A Color Test and Other Methods for Quality of Milk—B. H. NISSEN 168
Dairy Notes 174

PUBLISHED BI-MONTHLY
THE WILLIAMS & WILKINS COMPANY
MT. ROYAL AND GUILFORD AVES.
BALTIMORE, U. S. A.

Copyright, 1925, by The Williams & Wilkins Company

Made in United States of America

Every Operation Is Controlled Perfectly by the Cherry Automatic System of Milk Pasteurization!

This is what it will do

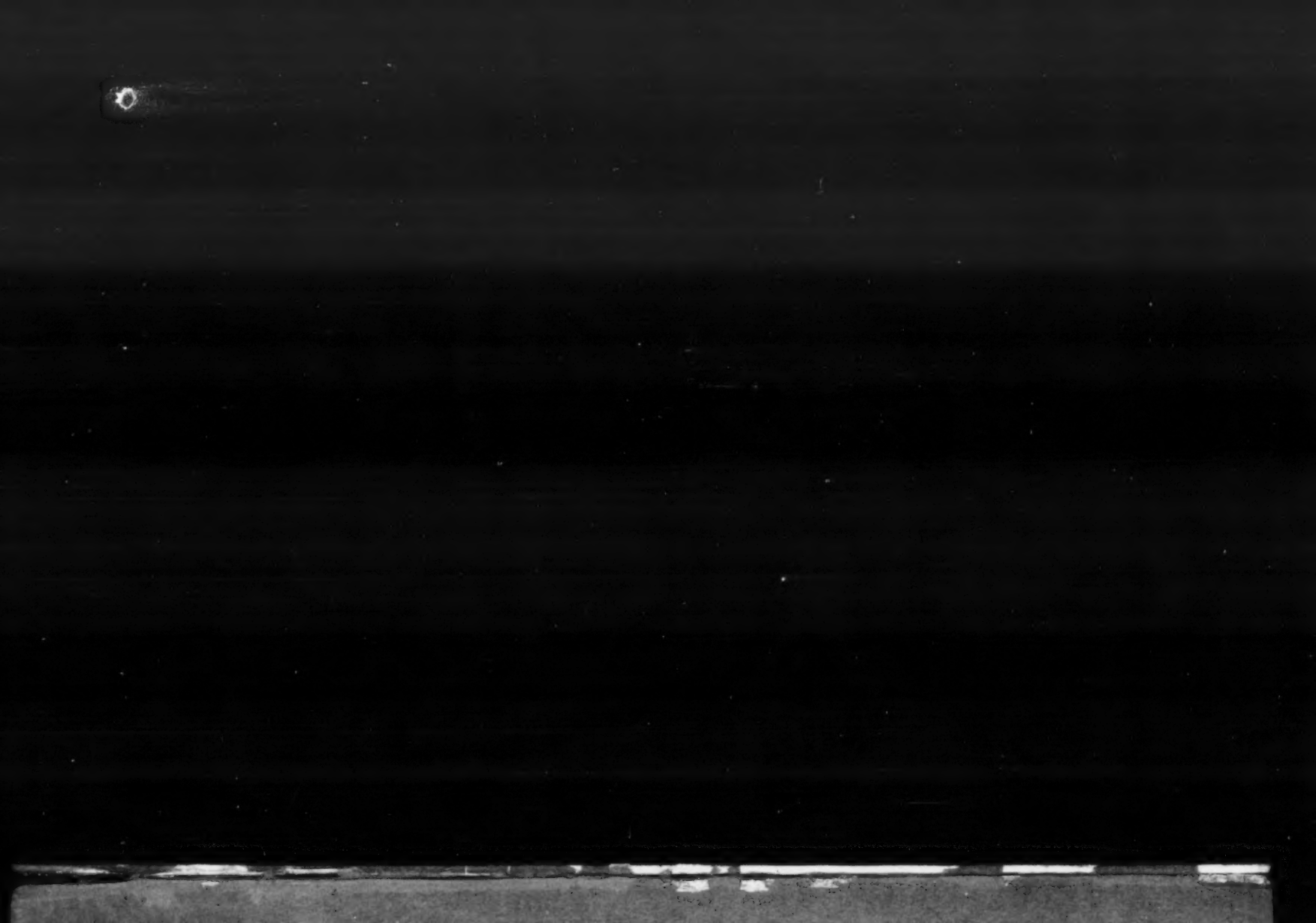
(1) Guarantee accurate control of holding time and temperature of product.
(2) Assure a deeper cream line and reduced bacteria count.
(3) Effect marked reductions in fuel costs.
(4) Retain the natural flavor of the Milk.
(5) Eliminates human element and all subsequent chance of error.

Unless you have investigated this marvelous control, you cannot realize its merits. Let us send you Bulletin No. 2065 which describes this new, positive, pasteurizing process.

Write for it today. Bulletin No. 2065.

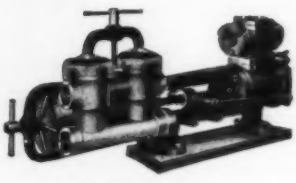
J.G. CHERRY COMPANY
CEDAR RAPIDS IOWA
St. Paul, Minn. Tama, Iowa. Peoria, Ill.

Entered as second-class matter June 9, 1917, at the Postoffice at Baltimore, Md., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103,
Act of October 3, 1917, authorized on July 16, 1918.

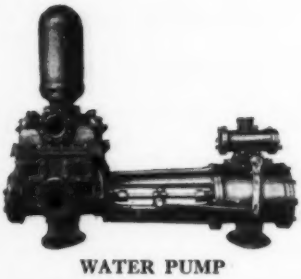


"DAVIDSON" PUMPS

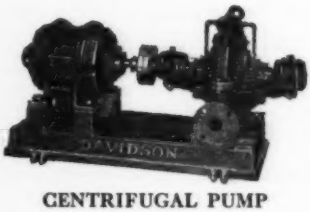
for Creameries and Milk Plants



MILK PUMP



WATER PUMP



CENTRIFUGAL PUMP

MILK PUMPS

BOILER-FEED PUMPS

BRINE-CIRCULATING PUMPS

TANK SUPPLY PUMPS

WASHER PUMPS

ARTESIAN WELL PUMPS

Strict adherence for more than 40 years to our policy of high grade materials and first-class workmanship have produced

"The Best Pump Built"

Send for Catalog and References in Your Vicinity

M. T. DAVIDSON COMPANY

154 Nassau Street, New York

135 Oliver St., Boston, Mass.
1011 Chestnut St., Philadelphia, Pa.
1224 Granite Building, Rochester, N. Y.
604 Empire Building, Detroit, Mich.
430 Transportation Building, Washington, D. C.
37 W. Van Buren Street, Chicago, Ill.

Your advertisement is being read in every State and in 25 Foreign Countries

INFORMATION FOR SUBSCRIBERS AND CONTRIBUTORS

THE JOURNAL OF DAIRY SCIENCE is issued bi-monthly, appearing in January, March, May, July, September and November. Each volume will consist of approximately 500 pages. Subscription is by the volume only and not by the year. One volume a year is issued at present.

Twenty-five reprints without covers of articles will be furnished gratis to contributors when ordered in advance. A table showing cost, with an order slip is sent with proof.

Manuscripts should be typewritten and carefully revised before submission and should be sent to Prof. J. H. Frandsen, 1401 N. 33d Street, Lincoln, Nebraska.

Correspondence concerning business matters should be addressed to THE WILLIAMS & WILKINS COMPANY, Publishers of Scientific Journals and Books, Mount Royal and Guilford Avenues, Baltimore, U. S. A.

1924 Volume: Volume VII, $5.00, United States, and countries within the postal union; $5.50, countries outside the postal union. Prices are net, postpaid.

Back Volumes: Volumes I–VI, incl., $36.00, United States, Canada, Mexico, Cuba; $39.00, other countries. Single numbers, $1.25. Prices are net, postpaid.

Subscriptions are received:

For Argentina and Uruguay: Beutelspacher y Cia., Sarmiento 815, Buenos Aires.

For Australia: Angus & Robertson, Limited, Sydney; Stirling & Co., 317 Collins St., Melbourne.

For the British Empire, except Australia and Canada: Bailliere, Tindall & Cox; Arthur F. Bird; Wm. Dawson & Sons, Ltd.; Dulau & Co., Ltd.; H. K. Lewis & Co.; David Nutt; J. Poole & Co.; Wheldon & Wesley, Williams & Norgate, London; James Thin, Edinburgh.

For Canada: Wm. Dawson and Sons, Ltd., 87 Queen Street, East, Toronto, Canada.

For Denmark: H. Hagerup's Boghandel, Gothersgade 30, Kobenhavn.

For France: Emile Bougault, 48 Rue des Ecoles, Paris.

For Germany: R. Friedländer & Sohn, Buchhandlung, Carlstrasse 11, Berlin NW. 6.

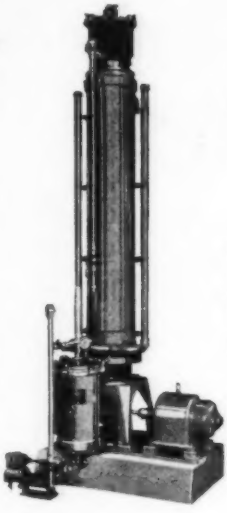
For Holland: Scheltema & Holkema, Rokin 74–76, Amsterdam.

For Japan and Korea: Maruzen Company, Ltd. (Maruzen-Kabushiki-Kaisha) 11 to 15 Nihonbashi Tori-Sanchome, Tokyo; Fukuoka, Osaka, Kyoto, and Sendai, Japan.

For Spain: Ruiz Hermanos, Plaza de Santa Ana, 13, Madrid.

For the United States and all other countries except as above: THE WILLIAMS & WILKINS COMPANY, Mount Royal and Guilford Avenues, Baltimore, U. S. A.

Claims for copies lost in the mails must be received within thirty days (domestic), ninety days (foreign) of the date of issue. Changes of address must be received at least two weeks in advance of issue.



THE PROBLEM OF CREAM DEODORIZATION SOLVED

THE ZAHM DEODORIZER ABSOLUTELY REMOVES ALL ONION, GARLIC AND OTHER UNDESIRABLE FLAVORS FROM CREAM OR MILK, AND PASTEURIZES SIMULTANEOUSLY IN VACUUM.

— *FEATURES* —

It is continuous and practically automatic in operation.
It is easily and quickly cleaned and sterilized.

THE ZAHM CONTINUOUS MILK EVAPORATOR

RETAINS MAXIMUM FOOD VALUE AND FLAVOR IN MILK PRODUCTS

— *ADVANTAGES* —

It is sanitary and easy to clean.
It gives maximum steam efficiency.
It is practically automatic in operation.
It requires the least floor space.
The product is exposed to heat only a few seconds.

RESULTANT—FINEST OBTAINABLE PRODUCTS

Write us for detailed information, capacities and prices

ZAHM & NAGEL CO., INC.

74 JEWETT AVE., BUFFALO, N. Y.

Your advertisement is being read in every State and in 25 Foreign Countries

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF THE
AMERICAN DAIRY SCIENCE ASSOCIATION

J. H. FRANDSEN, Editor
Lincoln, Nebraska

ASSOCIATE EDITORS

F. W. BOUSKA, Chicago, Ill.
A. A. BORLAND, State College, Pa.
C. H. ECKLES, St. Paul, Minn.
R. C. FISHER, Storrs, Conn.
J. B. FITCH, Manhattan, Kans.
J. A. GAMBLE, College Park, Md.
E. S. GUTHRIE, Ithaca, N. Y.
H. A. HARDING, Detroit, Mich.
S. H. HARVEY, College Park, Md.
O. F. HUNZIKER, Chicago, Ill.
H. H. KILDEE, Ames, Iowa
C. W. LARSON, Washington, D. C.
H. F. JUDKINS, Amherst, Mass.
M. MORTENSEN, Ames, Iowa
LEROY S. PALMER, St. Paul, Minn.
T. R. PIRTLE, Washington, D. C.
O. E. REED, Lansing, Mich.
C. L. ROADHOUSE, Davis, Calif.
L. A. ROGERS, Washington, D. C.
H. A. RUEHE, Urbana, Ill.
W. A. STOCKING, JR., Ithaca, N. Y.
IVAN C. WELD, Washington, D. C.
G. C. WHITE, Storrs, Conn.

OFFICERS OF AMERICAN DAIRY SCIENCE ASSOCIATION

President ..... O. E. REED, East Lansing, Michigan
Vice President ..... H. F. JUDKINS, Amherst, Massachusetts
Editor ..... J. H. FRANDSEN, Lincoln, Nebraska
Secretary-Treasurer ..... J. B. FITCH, Manhattan, Kansas

Officers of Different Sections

SECTION NO. 1—DAIRY PRODUCTION

Chairman ..... J. A. GAMBLE
Secretary ..... J. P. MCMASTER

SECTION NO. 2—DAIRY MANUFACTURES

Chairman ..... H. F. JUDKINS
Secretary ..... N. E. OLSON

SECTION NO. 3—EXTENSION

Chairman ..... L. W. MORLEY
Secretary ..... C. A. HUTTON

SECTION NO. 4—OFFICIAL TESTING

Chairman ..... G. C. WHITE
Secretary ..... C. E. WYLIE

Officers of Different Divisions

SOUTHERN ..... C. E. WYLIE, *Chairman*
J. A. GAMBLE, *Secretary*

EASTERN ..... A. A. BORLAND, *Chairman*
R. W. SMITH, JR., *Secretary*

WESTERN ..... H. A. BENDIXEN, *Chairman*
N. A. JAMISON, *Secretary*

Your advertisement is being read in every State and in 25 Foreign Countries

Nafis Laboratory Glassware

for Testing Milk and Its Products

has proved its Economy through its

Accuracy and Quality

THE THOUSANDS WHO USE IT YEAR AFTER YEAR, DO SO BECAUSE THEY HAVE FOUND IT PAYS THEM TO USE IT.

They have found by experience that:

Its ACCURACY is absolutely GUARANTEED and dependable.

The articles are made of a FINE QUALITY OF GLASS PROPERLY ANNEALED.

The PRICES are CONSISTENT with the EXCELLENT VALUES GIVEN.

Insist on having NAFIS GLASSWARE. If your jobbers cannot supply you do not accept substitutes but write for our catalog and the names of our distributors in your territory.

LOUIS F. NAFIS, Inc.

Manufacturers of Scientific Glassware for Testing Milk and Its Products.

17-23 North Desplaines St., Chicago, Ill., U. S. A.

ASK THE MEN WHO USE IT

Your advertisement is being read in every State and in 25 Foreign Countries

Hygienic Fundamentals of Food Handling

By CHARLES THOM AND ALBERT C. HUNTER

of the Microbiological Laboratory, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

Doctor Thom and Doctor Hunter are especially well qualified to write with authority because their daily work in the Bureau of Chemistry concerns problems in food sanitation.

From out of their fund of experience and research work covering many years the authors have discussed such problems as:

How food may be kept free from contamination with dirt, filth, disease germs; how to prevent spoilage due to contamination.

Constitution of foodstuffs as a first consideration in deciding upon methods of food handling and distribution.

Standards of fitness for foods.

Principles of food preservation.

Types of spoilage, food poisoning, and food infections.

A second section of the book shows how the general principles set forth in the first section apply to certain groups of foods such as:

CEREALS	EGGS
FRUITS & VEGETABLES	MILK
PICKLES & SAUER KRAUT	CHEESE
SHELLFISH	BUTTER
POULTRY	FISH
WATER & BEVERAGES	MEAT & MEAT PRODUCTS

A practical book based on scientific facts of decided interest to everyone concerned with the handling of foodstuffs.

Price $3.00 Postpaid

THE WILLIAMS & WILKINS COMPANY

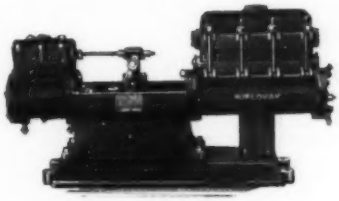
Publishers of Scientific Books and Periodicals

BALTIMORE, MARYLAND

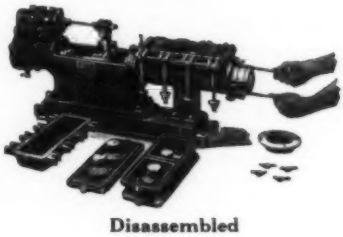
Your advertisement is being read in every State and in 25 Foreign Countries

BUFFLOVAK

Sanitary Milk Pumps



Assembled



Disassembled

A pump that overcomes the difficulties peculiar to pumping milk product

THE BUFFLOVAK Sanitary Milk Pump overcomes the difficulties peculiar to pumping milk products. All parts in the liquor end of the pump including the cylinder, piston and valve mechanism, are made entirely of bronze, so that the most exacting sanitary requirements of the dairy industry are completely fulfilled.

The utmost accessibility is afforded by its simplicity of construction. By loosening eight nuts, the entire valve mechanism may be completely disassembled for cleaning.

The piston may be withdrawn after removing four wing nuts which hold the cylinder head in place.

BUFFALO FOUNDRY & MACHINE CO.

1581 Fillmore Ave., Buffalo, N. Y.

NEW YORK **CHICAGO**

Your advertisement is being read in every State and in 25 Foreign Countries

Low Cost Sterilizing

Hypochlorite Sterilizing not Expensive

It is with greatest of interest that we report from time to time the approval of the dairy industry of sterilizing with hypochlorites as advocated by the General Laboratories for over ten years. There seems, however, in a few places, to be a misunderstanding on the matter of the cost so we give you the actual figures here that you may judge for yourself.

1. MILK PRODUCER

A farmer with a strainer, three pails and six cans to take care of daily, possibly also a cooler. Scrubbing this material twice daily in the following manner. Utensils first rinsed with cold water, then scrubbed with warm water and washing powder and rinsed with hot water and then B-K dilution at the rate of one ounce to three gallons of water. The amount of rinse dilution required to cover all utensils does not exceed a gallon and a half if used as directed. The total cost per day, mixing the disinfecting solution fresh for each use, one ounce of B-K bought in one gallon jugs—*2¼c per day.*

2. FARM DAIRY—MILK ROUTE

Approximately the same size dairy as number 1 but with 200 milk bottles and a small filler to wash in addition. Same procedure of cleaning used except that dilution required is more. The dilution required is about three gallons for one milking and five gallons for the next, making a total of eight gallons. Amount of B-K required is about three ounces, *cost 6c per day* bought in five gallon jugs.

Assuming that the above dairy has 30 cows, multiply cost to get approximate cost in larger dairies, making allowance for the fact that the increase in the amount of dilution required for rinsing purposes is not directly in proportion to the number of cows.

3. WASHING UDDERS

Where a particularly high grade of milk is being produced and cows' udders are washed with B-K dilution to prevent spread of disease and for sterilizing, add to the 6c per day 4c more, bringing it up to *10c per day.*

4. MILKING MACHINE USED

Where a milking machine is used consisting of not over three sets of teat cups and tubing, the amount of B-K required is two ounces to five gallons of water and one ounce added every day for a week; then the dilution is discarded and made fresh. The cost is *16c a week.*

5. BOTTLING PLANT

A large dairy plant using a B-K rinse from receiving vat to bottle filler, being pumped through, over and into everything that milk touches. This system is used to control bacteria on a large scale by one operation over entire equipment and can usually be done with 300 gallons of water containing 64 ounces of B-K. Dairies using this system are able to keep their counts down to 10,000 or 25,000 uniformly and report that when they discarded this system that the counts rose owing to difficulty of sterilizing coolers and other large equipment. The cost when used on this scale is *$1.15 per day.*

The foregoing examples are from actual use in dairies today. The examples are not as extensive as we can give to cover the subject, but our space here is limited.

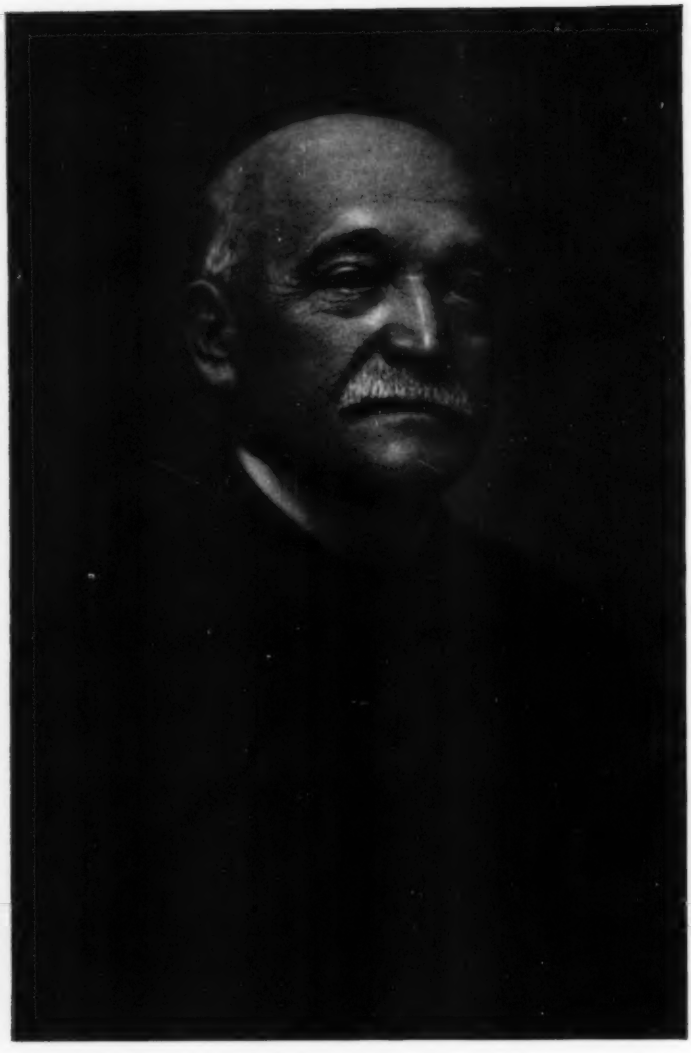
Write us for plan and cost in your dairy

GENERAL LABORATORIES

DEPT. A

MADISON, WIS.

Your advertisement is being read in every State and in 25 Foreign Countries



GEORGE A. SMITH

IN MEMORY OF GEORGE A. SMITH

Since we last met there has passed from among us one of the pioneers in American scientific dairying and the American Dairy Science Association expresses its appreciation of his life and work.

The Honorable George Alonzo Smith was born near Burlington, Otsego County, New York, on September 29, 1842. He intended to enter the ministry and received a thoro training in classical and religious literature.

While living on a farm to improve his health he became interested in the farm manufacture of cheese and because of his success with it, was soon making the milk of the neighborhood into cheese. In this way was developed one of the first cheese factories in the State of New York.

Upon the organization of a dairy division in the state government, his succses in the operation of a group of cheese factories led to his appointment as the first State Instructor in Cheese Making, probably the first appointment of its kind in the United States. For thirty-three years he remained a dairy teacher, a period of loyal service which has been rarely equaled.

His skill both as a teacher and as an administrator led to his appointment, in 1891, as Director of Farmers' Institutes and he helped lay the foundation of the present University Extension Work in Agriculture. In 1893 he directed the dairy exhibit for New York at the World's Fair at Chicago; in 1901 was in charge of the State dairy display at the Pan-American Exposition at Buffalo, and for years he took an active part in the dairy exhibit at the New York State Fair.

In connection with a reorganization of the New York State Agricultural Experiment Station there was created the position of Dairy Expert. Mr. Smith filled this position for twenty-three years, until his retirement in 1921. His work there was connected with studies of cheese ripening, tuberculosis and breeding problems of cattle, pasteurization and texture problems in butter, and various forms of teaching and inspection.

Quiet but vigorous, clean in mind and body, endowed with unusually good judgment, kindly almost to a fault, he was a man with a host of friends but singularly without enemies. To know him was to respect him.

THE TRIER COMPARED WITH THE WEDGE METHOD OF SAMPLING TUB BUTTER*

H. B. ELLENBERGER

University of Vermont, Burlington, Vermont

AND

E. S. GUTHRIE

Cornell University, Ithaca, New York

This paper is a preliminary report of a study in which the wedge and trier methods of sampling butter were compared. Although this work has not been completed, a summary of the results thus far obtained is given here in the hope that it may be of some assistance to inspectors, manufacturers, and dealers who are interested in accurately determining the composition of butter.

One of the most difficult problems of almost any analysis is to obtain a representative sample. Many commonly accepted methods of sampling a particular product have not been subjected to a careful study as to their accuracy. This seems to have been the case with butter.

We do not know the exact history of the trier and wedge methods of sampling butter, but we do know that the butter dealers have not been satisfied with the wedge system of sampling because it defaced the package. Perhaps the inspectors also were inclined to prefer the trier method on account of the large amount of time required to upset the tubs and partially or wholly strip them of their liners, preparatory to taking the wedge samples. It seems evident, therefore, that the trier method is more acceptable to both the butter merchants and the inspectors. The Bureau of Internal Revenue has, in most cases, given the butter dealer his choice of procedure in sampling.

Since the Bureau of Chemistry has had charge of the enforcement of the fat law, some of its stations have directed that the

* Received for publication January 20, 1925.

first samples should be taken with a trier. Then, if the package was suspected of being low in fat, it was to be sampled by the wedge method. From this it appears that the wedge system was generally considered more accurate; but a search of the literature has failed to reveal any convincing evidence of the truth of this opinion.

The old fat law of 82.5 per cent fat was antiquated many years ago; but on March 4, 1923, Congress passed a new law defining butter as follows:

> *Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That for the purposes of the Food and Drug Act of June 30, 1906 (Thirty-fourth Statutes at Large, page 768), "butter" shall be understood to mean the food product usually known as butter, and which is made exclusively from milk or cream, or both, with or without common salt, and with or without additional coloring matter, and containing not less than 80 per centum by weight of milk fat, all tolerances having been allowed for. Approved, March 4, 1923.

The administration of this act was placed in the hands of the Bureau of Chemistry in the Department of Agriculture, which had had charge of the enforcement of the old law. This Bureau immediately sought further information on proper sampling. Dr. H. W. Redfield, Chief of the New York Station, asked E. S. Guthrie to run a few determinations. At the same time, H. B. Ellenberger was coöperating with the Boston Station in a similar study of the two methods.

THE TECHNIQUE OF SAMPLING AND TESTING

The technique of each investigator in taking the samples should be clearly understood.

The wedge samples taken by Ellenberger were as follows, according to instructions received by him from the Boston Station of the Bureau of Chemistry:

The butter was removed from the tub, and the mass was cut with a wire completely through at the junctions of the upper and middle thirds and of the lower and middle thirds. The

bottom third was then removed, and a V-shaped piece was cut from each side of the middle section, extending from the circumference to the center of the tub. These two V-shaped pieces constituted the sample, which approximated one-half pound. This method was used by at least one station of the Bureau of Chemistry when there was good reason to believe that adulteration would be found.

All the samples taken by Guthrie were from butter that had been held at 42° to 55°F. He took the wedge samples with a knife, as instructed by the New York Station of the Bureau of Chemistry, making a four-sided plug, very much like a watermelon plug. These plugs were taken from opposite sides of a tub, at points not lower than one-fourth of the depth of the package from the bottom nor higher than the middle. The two portions together approximated one-half pound.

Ellenberger's trier sample consisted of two diagonal samples starting on opposite sides of the tub at the top and crossing near the center of the tub.

The vertical trier samples taken by Guthrie were as prescribed by the New York Station of the Bureau of Chemistry. A sample consisted of one trierful from the center of the tub, extending from the top to the bottom, and two other trierfuls, each taken half-way between the center plug and the edge of the package and diametrically opposite each other.

The diagonal trier sample taken by Guthrie was obtained by inserting the trier near the edge at the top and directing it to the bottom at the opposite side. This sample comprised only one trierful and contained about one-third as much butter as either his vertical trier or wedge samples.

The analyses made by Guthrie were determined by weighing the sample on a fine balance, sensitive to the fourth decimal place of a gram. Ten grams were weighed in an aluminum cup, and this sample was dried on an electric plate. The amount of fat in the residue, after the moisture had been thus evaporated, was determined by the Kohlman method.

Ellenberger also employed delicate balances, sensitive to the fourth decimal part of a gram. He followed the official method

of analysis outlined by the Association of Official Agricultural Chemists. He used a water oven to drive off the moisture, until the samples ceased to lose weight. He made all his determinations in duplicate.

THE RESULTS

Ellenberger first studied a lot of 34 tubs. In all but one test the wedge method showed more moisture than the trier. The maximum range of difference was from −0.15 to +1.35 per cent. That is, in one tub the wedge sample contained 0.15 per cent less moisture than the vertical trier sample, and in another tub the wedge sample showed 1.35 per cent more moisture than the vertical trier sample. The remaining samples ranged between these two extremes, the average variation being 0.69 per cent. The average percentage of moisture in the wedge samples was 0.68 per cent above that in the trier samples.

Guthrie found similar results in a series of 21 tubs, 6 of which were cold-storage goods. As in Ellenberger's analyses, in only one tub did the wedge sample show less moisture than the vertical trier sample. The maximum range of difference was from −0.19 to +0.82 per cent. The remaining samples ranged between these two extremes, the average variation being 0.38 per cent. The average percentage of moisture in the wedge samples was 0.36 per cent above the vertical trier samples.

Thus, what seemed to be a simple analytical problem became a complicated one. The question immediately arose, Which method of sampling is the more nearly correct? In the meantime, the Bureau of Chemistry had directed its inspectors to employ the trier system. Thus the buttermaker and his associates in the butter industry were given the benefit of the doubt.

Both investigators decided that the most nearly accurate sample would be obtained by putting the entire tub of butter into a dry, ten-gallon milk can and working it up in the same ways as the smaller trier and wedge samples had been worked. The whole tub of butter was softened by holding it in water at 90°F. for twelve to fourteen hours in a tightly closed can. It was then very thoroughly stirred to a creamy consistency.

Ellenberger used a can with a hole in the top through which the agitator could be operated, so that very little moisture escaped while the sample was being stirred. Guthrie stirred his sample with a long-handled paddle in a fairly humid atmosphere.

In this phase of the investigation, Ellenberger worked with 16 tubs of butter from several different creameries. He took two sets of trier samples and two sets of wedge samples from each tub. He then prepared the whole tub as described above, and took two samples and analyzed them separately. Altogether, he sampled each tub six times, and analyzed each sample in duplicate. Ellenberger found, in 31 comparisons from these 16 tubs, that the wedge sample showed an average of 0.07 per cent less moisture than the entire-tub sample, and that the trier sample (in this series all free moisture on the back of the trier was included) contained 0.17 per cent less moisture than did the entire-tub sample. The maximum range of difference was from −0.91 to +0.42 per cent for the trier method as compared with the entire-tub sample, and from −0.53 to +0.77 per cent for the wedge method as compared with the entire-tub sample. The average variation from the entire-tub analysis was 0.31 per cent for the vertical trier sample and 0.23 per cent for the wedge sample. However, 6 of these tubs, comprising twelve sets of samples, were unsalted butter. Separating the results of the salted and unsalted butter, we have the following:

From 10 tubs of salted butter 19 sets of samples were taken. The average analysis of the vertical trier samples was 0.34 per cent less, and of the wedge samples 0.11 per cent less, than the entire-tub samples. The maximum range of difference was from −0.91 to +0.21 per cent for the vertical trier samples, with an average variation of 0.39 per cent; and from −0.53 to +0.77 per cent for the wedge samples, with an average variation of 0.25 per cent. The remaining 6 tubs of unsalted butter gave 12 sets of samples. The average analysis of the vertical trier samples was 0.09 per cent less, and of the wedge samples .01 per cent less, than the whole-tub samples. The maximum range of difference was from −0.38 to +0.42 per cent for the trier

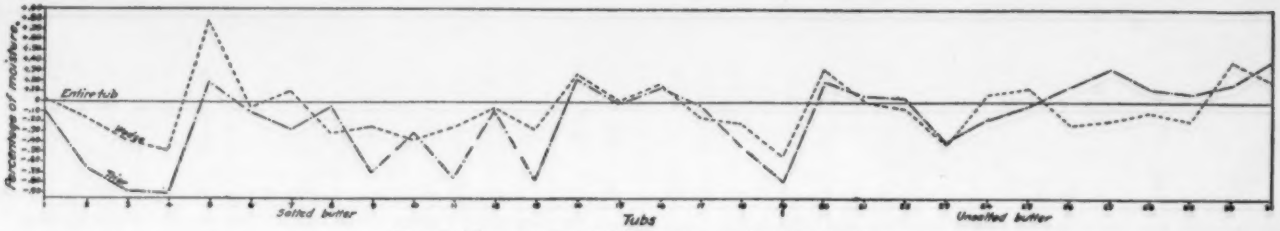


FIG. 1. VARIATIONS OF MOISTURE BY ELLENBERGER

The straight dark line is the entire-tub sample which is assumed to be correct. The other lines show the variations in moisture content from this assumed correct analysis.

The maximum range of difference was as follows: Vertical trier sample, −0.91 to +0.42 per cent; wedge sample, −0.53 to +0.77 per cent.

The average variations of both plus and minus analyses were: Wedge sample, 0.23 per cent; vertical trier sample, 0.31 per cent.

Finally and most important: The wedge sample contained an average of 0.07 per cent, and the vertical trier sample 0.17 per cent, less moisture than the entire-tub sample.

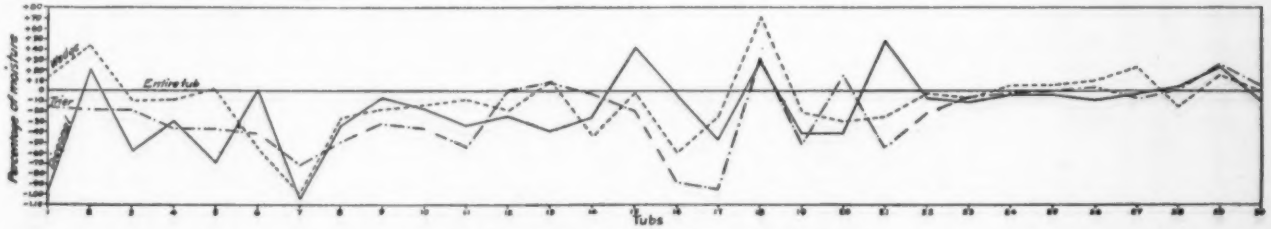


FIG. 2. VARIATIONS OF MOISTURE BY GUTHRIE

The straight dark line is the entire-tub sample which is assumed to be correct. The other lines show the variations in moisture content from this assumed correct analysis.

The maximum range of difference was as follows: Diagonal trier sample, −1.05 to +0.47 per cent; wedge sample, −1.02 to +0.47 per cent; vertical trier, −0.95 to +0.32 per cent.

The average variations of both plus and minus analyses were: Wedge sample, 0.24 per cent; vertical trier sample, 0.29 per cent; diagonal trier sample, 0.30 per cent.

Finally and most important: The wedge sample contained an average of 0.10 per cent, the diagonal trier sample 0.18 per cent, and the vertical trier sample 0.22 per cent less moisture than the entire-tub sample.

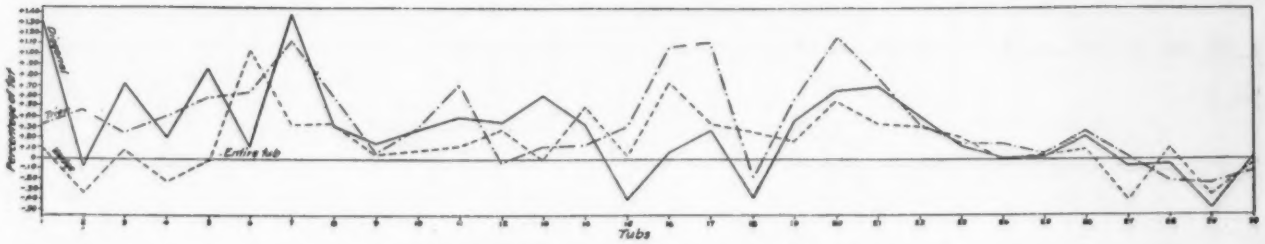


FIG. 3. VARIATIONS OF MILK FAT BY GUTHRIE

The straight dark line is the entire-tub sample which is assumed to be correct. The other lines show variations in milkfat content from this assumed correct analysis.

The maximum range of difference was as follows: Diagonal trier sample, −0.40 to +1.31 per cent; wedge sample −0.39 to +1.03 per cent; vertical trier sample, −0.22 to +1.17 per cent.

The average variations of both plus and minus analyses were: Diagonal trier sample, 0.39 per cent; wedge sample, 0.25 per cent; and vertical trier sample, 0.42 per cent.

Finally and most important: The wedge sample contained an average of 0.16 per cent, the diagonal trier 0.29 per cent, and the vertical trier 0.36 per cent, more fat than the entire-tub sample.

samples with an average variation of 0.19 per cent; and from −0.40 to +0.41 per cent for the wedge samples, with an average variation of 0.19 per cent.

As already noted, Guthrie, using a series of 30 tubs, compared diagonal trier, wedge, and vertical trier samples with an entire-tub sample. He studied the variation of both moisture and fat. He found, in the moisture analyses, that the wedge sample compared more favorably with the entire-tub than did either of the others. The average of the 30 tubs showed the wedge sample to contain 0.10 per cent less moisture, the diagonal trier sample 0.18 per cent less moisture, and the vertical trier sample 0.22 per cent less moisture, than the entire-tub sample. The maximum range of difference was from −1.05 to +0.47 per cent for the diagonal, from −1.02 to +0.72 per cent for the wedge, and from −0.95 to +0.32 per cent for the trier, with average variations of 0.30, 0.24, and 0.29 per cent, respectively. The fat analyses also showed the wedge sample to be the closest to the entire-tub sample. The wedge contained 0.16 per cent, the diagonal 0.29 per cent, and the trier 0.36 per cent more moisture than the entire-tub sample.

In order that these data may be visualized, figures 1, 2, and 3 have been prepared. Figure 1 shows the variations in moisture, from package to package, in the 31 sets of samples from the 16 tubs sampled and analyzed by Ellenberger. Figures 2 and 3 show the variations in the moisture and fat in the 30 tubs studied by Guthrie.

In regard to the accuracy of the analyses, most of the time the difference between the first analysis and its duplicate was less than 0.05 per cent.

SUMMARY

The wedge method of sampling seems to be the most nearly accurate, as shown by Ellenberger's moisture analyses and Guthrie's moisture and fat analyses; but it also seems reasonable to take a diagonal sample first, because this is easily obtained without removing much butter from the package. If this sample gives indications of a low fat content, a second sample can then be taken by the wedge method.

PHASES NOT YET REPORTED

As has already been stated, further research on this problem is necessary. Ellenberger has found that there is a distinct difference in the moisture content when different triers are used. Perhaps this is also true when different knives are used to take the wedge samples. Guthrie has been paying special attention to the working of the butter. These, and other related problems, are still being studied.

YEAST AS A SUPPLEMENTARY FEED FOR LACTATING COWS[1]

C. H. ECKLES AND V. M. WILLIAMS

Division of Dairy Husbandry, University of Minnesota, St. Paul, Minnesota

In a previous report results were given of the addition of yeast to the rations of growing calves. A second part of the investigation concerned the effect of using yeast as a supplementary feed for cows in milk and the influence upon the vitamin B content of the milk produced.

The requirements of the bovine for vitamins have not been determined as yet. Until sufficient experimental evidence is available to justify a different conclusion it would appear advisable to assume that this species has a vitamin requirement in general similar to that of laboratory animals, which have supplied the data upon which the present knowledge of vitamins is based.

The rations commonly fed cows in well managed dairy herds apparently would supply a liberal amount of vitamin B. At least half the nutrients are usually supplied in roughages which undoubtedly contain a fair amount of vitamin B. The remainder of the ration usually consists of ground grains and by-products. Seeds are looked upon as supplying a liberal amount of vitamin B, and when ground corn, oats, barley, or other grains are used it is certain the ration will contain vitamin B in considerable amounts. It would appear that the only possibility of a ration low in vitamin B would occur when by-products low in this accessory were used in excess. Gluten meal and beet pulp are examples of by-products low in this vitamin.

The logical procedure in studying the relation of a vitamin to the feeding of dairy cattle would appear to be as follows.

[1] Received for publication July 9, 1924.

a. Determine if the bovine requires the vitamin in question as do the laboratory animals.

b. An estimation of the quantitative requirements in terms of some feeding stuff serving as an especially potent source of the vitamin.

c. Determine if any danger exists of ordinary rations being deficient in the vitamins in question.

d. Find if any advantage results from supplying the vitamin in amount considerably in excess of the minimum demands of the animals and of the amount usually received through the ration.

The study which is reported in this paper for reasons which were explained in the first report did not follow the procedure suggested but began with the last rather than the first of the four parts outlined. Large quantities of spent yeast are available from breweries and the use of this product as a feed for animals has long been common in Europe. In Europe yeast is looked upon as a source of efficient protein rather than a supplementary feed having special effects such as might be expected if it were fed for the sake of a vitamin it might furnish.

According to Sherman and Smith "While often referred to as growth promoting it should be emphasized that vitamin B is essential to normal nutrition at all ages."

"The mechanism of the action of vitamin B has been variously thought to be that of a physiological stimulant to glandular secretion of an indirect metabolic stimulant, particularly for carbohydrates." "While the relation of vitamin B to cellular metabolism seems still a matter of speculation, it is clear that it often exerts a very direct influence upon appetite."

EXPERIMENTAL

With these facts in mind it appeared worth while to test the value of yeast as a supplement to a common ration as fed under practical conditions. The results were to be measured from the practical feeds standpoint as indicated specifically by effect upon milk production and in general upon condition and appetite of the animal as noted by observation. If the yeast

possesses properties of a galactogog its addition to the ration should result in a stimulation of the mammary glands or by increasing the efficiency of the digestive and assimilative functions. The former might cause an increased appetite to compensate for the increased secretion while the latter might make an increased secretion possible by furnishing the mammary glands with more nourishment.

The plan of the experiment was to feed commercial dry yeast at the rate of 25 grams daily for each pound of milk produced. This particular amount was chosen arbitrarily but as at least furnishing even more than the maximum amount that could be fed under commercial conditions. Eight cows were used, arranged in two groups and fed according to the reversal plan as follows:

	GROUP 1	GROUP 2
Period 1 (40 days)	Yeast supplement	Basal ration
Period 2 (40 days)	Basal ration	Yeast supplement
Period 3 (40 days)	Yeast supplement	Basal ration

The first ten days of each period were considered preliminary. The comparison of data in each case is for the thirty-day periods following the preliminary. The ration used consisted of alfalfa hay, corn silage, dried beet pulp and a grain mixture of ground corn 2 parts, ground oats 2 parts, wheat bran 2 parts, and linseed oilmeal 1 part. The plan of feeding in general was to give each animal as much roughage as she would consume readily and in addition a supply of grain somewhat more than necessary to supply the protein and energy needed, according to Armsby's standards. The purpose in supplying some surplus of nutrients was to allow any stimulation from the yeast to exert its full effect without the limitation from a deficiency of nutrients. The energy fed ranged from 120 to 135 per cent of that called for by the feeding standard. A summary of milk and fat produced by the individuals used is given in table 1. The reversal plan of arranging experimental periods of feeding recognizes the fact that after the first month under normal conditions the decline

in milk production follows a rather uniform curve until the end of the lactation period approaches. The average of the first and the third period should, therefore, be practically the same as the figure for the second period. The object in arranging one group with the experimental ration the first and the third, while for the other group the experimental ration in the second

TABLE 1

Summary of milk and fat production

ANIMAL NUMBER	MILK PER DAY			BUTTERFAT PER DAY		
	First 30-day period	Second 30-day period	Third 30-day period	First 30-day period	Second 30-day period	Third 30-day period
	pounds	pounds	pounds	pounds	pounds	pounds
Group 1						
120	24.46*	22.47	19.95*	1.181*	1.115	1.035*
301	39.84*	37.80	37.85*	1.135*	1.026	1.097*
317	23.06*	20.64	11.75*	0.872*	0.752	0.503*
320	27.41*	27.13	26.78*	0.922*	0.877	0.918*
Average	28.69*	26.51	24.08*	1.027*	0.942	0.888*
Average for first and third periods		26.38			0.957	
Group 2						
102	10.99	8.46*	8.73	0.509	0.428*	0.456
306	33.89	32.17*	31.91	1.190	1.024*	0.988
333	34.20	31.32*	26.05	1.077	1.024*	0.875
500	32.57	29.13*	26.57	1.232	1.115*	1.078
Average	27.91	25.27*	23.31	1.002	0.897*	0.849
Average for first and third periods		25.61			0.925	

* Receiving 25 grams dried yeast per pound of milk.

period is to check environmental factors such as weather conditions, that might otherwise not be detected. The results in table 1 do not indicate any effect from the addition of yeast to the ration. In the first group the average milk yield for the yeast periods was 26.4 pounds per day and for the second without yeast 26.5. In the second group the average of the two

basal periods was 25.6 pounds compared to 25.5 for the yeast period.

CONCLUSIONS

Adding a dried yeast preparation at the rate of 25 grams per pound of milk produced to a ration commonly fed in good dairy herds did not increase the milk or butterfat yield.

No effect could be observed in the way of condition of the animal or stimulation of appetite.

THE EFFECT OF CANE MOLASSES ON THE DIGESTIBILITY OF A COMPLETE RATION FED TO DAIRY COWS*

PAUL S. WILLIAMS

Department of Dairy Husbandry, Pennsylvania State College, State College, Pennsylvania

Cane molasses has been used as feed for live stock for many years. It has served especially as an appetizer or for increasing the palatability of grains and roughages. A few experiments have been run by various stations to determine the feeding value of molasses as compared with grains, while a larger number have been run to determine its effect on the digestibility of the ration.

The United States produced in 1919 over sixteen million gallons of cane molasses, and imported approximately 160 million gallons. (1) Part of this is used for the manufacture of alcohol, small quantities for domestic consumption and the remainder, which as nearly as the writer can determine amounts to approximately 10 to 15 per cent, goes for stock feeding purposes.

SUMMARY OF PREVIOUS EXPERIMENTS

The results reported by Lindsey and Smith (2) indicate that cane molasses in the ration as a general rule depresses digestibility. Patterson and Outwater (3) got results which conflict with those of Lindsey and Smith. Their investigations indicated a beneficial effect on digestibility. As a result of the favorable report made by Patterson and Outwater, extravagant claims have been put forth by companies dealing in molasses as to its value in increasing the digestibility of the other feeds in the ration. In view of the fact that sufficient experimental data to settle the question definitely have not been established, and that some of the results are conflicting, the following investigation was planned in order to give further light on the question.

* Received for publication January 8, 1925.

OBJECT OF EXPERIMENT

The object of this investigation was to determine the effect of cane molasses on the digestibility of a complete ration fed to dairy cows.

TABLE 1

COW NUMBER	AGE JANUARY 18, 1923	DATE OF LAST FRESHENING	WEIGHT AT BEGINNING OF EXPERIMENT*	DATE BRED	MILK PER DAY AT BEGINNING OF EXPERIMENT*
848	7 years, 299 days	11/21/22	1198	4/ 4/23	50
860	6 years, 213 days	12/10/22	1256	4/25/23	37
855	7 years, 50 days	11/30/22	1556	4/ 2/23	59
1117	5 years, 33 days	12/24/22	1153	3/19/23	47

* Average of first three days of the experiment.

TABLE 2

	AMOUNT
	pounds
Corn meal	200
Wheat bran	150
Ground oats	150
Linseed meal (old process)	75
Peanut meal	100
Diamond gluten meal	50
Salt	5

PLAN AND PROCEDURE OF EXPERIMENT

The general plan of the experiment was as follows:

Series A—Trial 1: Check trial. Four pure bred Holstein cows were fed a grain ration with hay and silage.

Series A—Trial 2: The same four cows were fed as in trial one with the addition of sufficient molasses to make up 15 per cent of the total concentrates.

Series A—Trial 3: The same cows were again fed as in trial one with the addition of sufficient molasses to make up 25 per cent of the total concentrates.

Trials one, two and three were repeated and designated as series B. The three trials were again repeated and designated

as series C. A total of nine trials were thus included in series A, B and C.

The amounts of molasses fed in trial number two of each series is, according to general feeding practice, a medium amount. The amounts fed in trial three of each series is a large amount.

Each trial covered a period of twenty-one days which was divided into a preliminary feeding period of ten days and a collection period of eleven days.

The experiment was begun January 18, 1923 with series A—trial 1, and ended at the close of series C—trial 3, July 25, 1923.

It will be observed that a complete ration for dairy cows in milk was fed throughout the whole experiment. At the beginning of the experiment a special effort was made to balance up the rations according to the maintenance and milk production requirements of the Armsby feeding standard.

COWS USED IN THE EXPERIMENT

Table 1 shows how the cows compared with each other.

The grain ration fed during the entire experiment was made up as shown in table 2.

Using the average feed analysis from Pennsylvania Bulletin 161, 1 pound of this mixture contains 0.169 pounds true digestible protein and 0.759 therms net energy.

A quantity of the grain mixture sufficient to last through six trials was prepared before the experiment started. This grain was thoroughly mixed and then stored in bags ready for use. Just previous to each of the trials, the individual feeds were weighed up into lard pails with tight fitting lids. A total of two hundred fifty-two feeds were so prepared at the beginning of each twenty-one day trial. A composite sample for chemical analysis was taken at the time individual feeds were weighed.

Alfalfa of rather low quality was fed to the cows in series A and B. In series C, mixed hay of good quality, approximately 60 per cent clover and 40 per cent timothy, was fed. The hay was prepared for feeding and thorough mixing by cutting it into short lengths. Two hundred fifty-two individual feeds of hay were weighed into bags just previous to each trial. A composite sample for chemical analysis was taken at this time.

The silage was of good quality. It was weighed fresh from the silo each day in individual feeds. Samples of equal size were taken each day and put immediately into the drying oven.

All feed samples were dried as completely as possible in the steam heated oven. They were then removed and allowed to stand for a few days until their moisture content came into equilibrium with the atmospheric moisture. Finally they were weighed and ground in preparation for chemical analysis.

One analysis of cane molasses was made from a composite sample taken dairly during the entire experiment.

No appreciable gain or loss in weight of the cows occurred throughout the nine trials of the experiment. This fact is an indication that the ration supplied about the correct amount of energy.

Using the analyses given in Pennsylvania Bulletin 161, the rations fed to each cow satisfied the Armsby Feeding Standard both for protein and energy at all times.

The cows were all in fair to good conditions at the beginning of the experiment and remained so throughout the nine trials.

When a cow refused any part of her daily feed she was immediately removed from the experiment until such time as she consumed the regular ration, and then she was not included in any digestion trial unless she had received the ration without change in amount for at least ten days previous to the beginning of the trial. Two of the cows No. 855 and No. 1117 went through the entire experiment without missing a feed. Cow No. 860 was off feed and therefore not included in trial 2, series B, and trial 3, series C. Cow No. 848 was off feed during trial 2, series C.

COLLECTION OF EXCRETA AND METHOD OF TAKING SAMPLES

Two men were in attendance at all times during the collection period. All dung voided by each cow was caught in a scoop shovel, a separate shovel being used for each cow. The dung collected was weighed once each day at 8'oclock a.m. Care was taken that exactly ten days were included in each trial.

The urine was swept down the drain as voided. Since straw or shavings could not be used as bedding, burlap bags were

tacked to the cork brick floor on which the cows stood. These were changed at frequent intervals, so that the cows had a fairly comfortable bed at all times.

In order that the digestion trials be run under as nearly normal conditions as possible the first day of the eleven days trial was discarded. This preliminary day was allowed so that the cows might recover from any excitement likely to be caused at the beginning of a digestion trial.

Exact aliquot samples of dung were taken daily and preserved as a composite for the ten-day period. At the close of this period a portion of the sample was used for nitrogen determinaminations by the Köenig method. The remaining part of the sample was oven dried and ground for determination of the other constituents. The method of drying and grinding conformed to that described above concerning feed samples.

CARE OF THE COWS

The stalls used were provided with steel mangers with high sides to prevent the cows from eating the feed that belonged to adjacent animals. Feeding and watering were done at regular intervals three times daily immediately before milking. In addition to the regular watering the cows were given an opportunity to drink each day immediately after weighing at 10 o'clock a.m. The hay, silage, grain, and molasses were all fed together at one time, the hay being placed in the bottom of the manger and the other feeds on top of it in the order mentioned. The molasses was dissolved in about double its weight of warm water and was poured over the other feeds after they were put into the manger.

MILK PRODUCTION

A study of the milk production shows that the cows gradually fell off during the entire experiment at a rate about equal to what one would naturally expect under conditions of advance in lactation.

TABLE 3

Digestibility of nutrients by trials

SERIES	TRIAL	DATE	MOLASSES IN DRY MATTER OF RATION	CRUDE PROTEIN	CRUDE FIBER	NITROGEN FREE EXTRACT	ETHER EXTRACT	DRY MATTER
			Cow 848					
			per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
A 1	Check	1/29–2/ 7		69.678	44.608	71.199	77.110	64.576
A 2	Molasses	2/19–2/28	5.202	63.648	42.717	70.188	72.340	62.624
A 3	Molasses	3/12–3/21	9.856	61.218	54.166	67.033	65.670	61.702
B 1	Check	4/ 1–4/10		65.436	55.904	70.695	70.895	65.328
B 2	Molasses	4/23–5/ 2	4.918	63.410	46.900	71.410	75.123	63.690
B 3	Molasses	5/14–5/23	9.684	60.646	53.641	69.306	74.877	62.933
C 1	Check	6/ 4–6/13		63.047	56.903	71.906	71.727	66.150
C 2	*	6/25–7/ 4						
C 3	Molasses	7/16–7/25	12.386	61.460	65.330	71.650	72.448	64.053
			Cow 860					
A 1	Check	1/29–2/ 7		66.439	45.366	71.640	56.876	65.011
A 2	Molasses	2/19–2/28	5.202	62.616	42.717	70.719	72.340	62.545
A 3	Molasses	3/12–3/21	9.856	59.684	44.979	70.894	81.854	62.024
B 1	Check	4/ 1–4/10		67.291	54.256	71.642	70.722	65.906
B 2	*	4/23–5/ 2						
B 3	Molasses	5/14–5/23	9.684	57.641	50.878	70.242	71.008	62.404
C 1	Check	6/ 4–6/13		63.047	56.903	71.906	71.727	66.150
C 2	Molasses	6/25–7/ 4	5.247	56.666	54.032	67.912	65.368	61.332
C 3	*	7/16–7/25						
			Cow 855					
A 1	Check	1/29–2/ 7		69.601	50.003	76.609	78.255	67.197
A 2	Molasses	2/19–2/28	5.893	63.398	41.050	70.980	73.617	62.938
A 3	Molasses	3/12–3/21	10.569	58.114	47.455	70.030	58.138	61.019
B 1	Check	4/ 1–4/10		65.410	48.899	68.900	75.706	62.727
B 2	Molasses	4/23–5/ 2	5.914	62.158	49.077	72.660	66.610	62.362
B 3	Molasses	5/14–5/23	10.356	58.387	55.162	70.686	73.850	63.039
C 1	Check	6/ 4–6/13		60.799	54.382	71.526	72.481	64.899
C 2	Molasses	6/25–7/ 4	5.035	61.685	58.623	71.851	73.889	65.740
C 3	Molasses	7/16–7/25	11.215	59.371	60.684	71.732	69.114	59.972

* Off feed.

TABLE 3—*Continued*

SERIES		TRIAL	DATE	MOLASSES IN DRY MATTER OF RATION	CRUDE PROTEIN	CRUDE FIBER	NITROGEN FREE EXTRACT	ETHER EXTRACT	DRY MATTER
Cow 1117									
				per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
A	1	Check	1/29–2/ 7		62.554	44.492	71.692	70.646	63.330
	2	Molasses	2/19–2/28	5.202	59.661	39.519	68.858	73.385	71.323
	3	Molasses	3/12–3/21	9.856	58.427	51.613	68.693	72.965	64.550
B	1	Check	4/ 1–4/10		64.434	53.919	74.197	71.953	67.200
	2	Molasses	4/23–5/ 2	4.918	59.592	51.439	73.093	68.593	63.690
	3	Molasses	5/14–5/23	9.684	56.980	52.028	71.643	74.442	63.371
C	1	Check	6/ 4–6/13		60.799	54.382	71.526	72.481	64.899
	2	Molasses	6/25–7/ 4	5.247	58.306	58.479	69.884	64.980	63.648
	3	Molasses	7/16–7/25	9.882	63.388	61.917	77.217	76.530	71.729

RESULTS OF DIGESTION TRIALS

The summary of results of the nine different digestion trials were computed in the usual way from the data. It should be explained here that it was assumed that molasses was completely digested. (2) Hence, the nutrients in the molasses were not added in as a part of the food consumed. This assumption permits of a direct comparison of the nutrients intake with that excreted in the dung, in determining the percentage of digestibility.

One encounters considerable difficulty in trying to interpret the results shown by data in table 3. It is observed that no one fact seems to hold true consistently throughout all the trials either for individual cows or for all cows.

Taking crude protein as an example, the molasses trials for the cows 848 and 860 show a depression in the digestibility, but on the other hand the cows 855 and 1117 show slight increases in digestibility.

The figures for digestibility of crude fiber show no regularity of increase or decrease of digestibility in relation to the amount of molasses consumed. The same can be said of ether extract and

nitrogen free extract. A decrease in digestibility where molasses was fed however appears to be evident when one examines the dry matter data. Taking cow 848 Group A for example, the check trial showed about 64.6 per cent; with 5.2 per cent of molasses in the dry matter, the corresponding figure is 62.6 per cent; and with 9.8 per cent molasses in the dry matter, the percentage digestibility is 62 per cent. Similar results are shown in series B and C for this cow. Studying the data of the other three cows, we find exactly the same thing with but three exceptions, viz., cow 855 in series B and cow 1117 in series A and C. In the first mentioned exception, it is seen that the low percentage of molasses

TABLE 4

Average digestibility for all cows by trials

SERIES	TRIALS	CRUDE PROTEIN	CRUDE FIBER	ETHER EXTRACT	NITROGEN FREE EXTRACT	DRY MATTER
		per cent	*per cent*	*per cent*	*per cent*	*per cent*
A 1	Check	67.482	46.205	71.205	72.074	65.101
A 2	Molasses	62.369	41.191	73.013	72.227	64.798
A 3	Molasses	59.338	49.362	69.278	69.190	62.284
B 1	Check	65.634	53.147	72.437	71.279	65.211
B 2	Molasses	52.469	58.366	69.942	72.398	63.230
B 3	Molasses	58.412	52.443	73.555	70.476	62.940
C 1	Check	62.243	51.425	68.549	69.116	62.767
C 2	Molasses	48.897	57.076	68.139	69.897	54.639
C 3	Molasses	61.385	62.587	72.670	73.695	65.616

causes the usual decrease, but the high percentage of molasses shows a digestibility even higher than the check trial. Exactly the same comment applies to the third mentioned exception. In the second exception, the low percentage molasses ration has a higher percentage of digestibility than the check trial while the high percentage molasses ration has also a slightly higher percentage of digestibility than the check trial. To sum up the dry matter data as shown in table 3, it is noted that out of the twenty-one possible comparisons of the different molasses trials with their respective check trials, 76.2 per cent of the molasses trials show a depressed digestibility. In the eight cases where de-

pressions are noted with both high and low percentages of molasses, it is seen that in six instances the greatest depression was caused by the greater amount of molasses, while in two instances the greater depression was caused by the smaller amount of molasses.

In order to study the data from the standpoint of averages, tables 4, 5 and 6 have been prepared. Table 4 presents an average percentage digestibility of the constituents.

The crude protein figures appear to indicate that molasses depressed digestibility since the digestibility of the protein in the check trial of each series ran higher than the corresponding molasses trials. With the exception of one average trial on high molasses in series C, the same comment may be offered concerning the dry matter data. The crude fiber figures show that the digestibility was increased by the molasses in four cases while in two cases it was decreased. The digestibility of the ether extract on the other hand is decreased by the molasses as often as it is increased.

Table 5 presents average figures for each of the four cows used in the experiment.

The method used in obtaining these figures may be illustrated as follows:

The respective amounts of feed consumed and digested by each animal in trial one of the three series of trials were added together and the average percentage digestibility was then worked by the usual method of computation. The average figures for trials two and three were obtained in the same way.

Before making a study of table 5 it should be pointed out that cow 848 was off feed in trial two, series C and cow 860 was off feed in trial three, series C. No data was obtained from these two cows in the trials mentioned, and consequently the figures Nos. 848 and 860 represent the average of two trials instead of three.

A study of the data presented here indicates that the molasses had no uniform effect on the digestibility of the different constituents. In six out of eight comparisons in the protein figures the percentage of digestibility is reduced by the molasses. In

TABLE 5

Average digestibility for cows by combining like trials in each series

A-B-C	TRIALS	AVERAGE PERCENTAGE OF MOLASSES IN DRY MATTER OF RATION	CRUDE PROTEIN	CRUDE FIBER	ETHER EXTRACT	NITROGEN FREE EXTRACT	DRY MATTER
			Cow 848*				
			per cent	*per cent*	*per cent*	*per cent*	*per cent*
1-1-1	Check		66.307	52.448	73.457	70.457	65.329
2-2	Molasses	5.202	66.531	45.002	73.724	70.783	63.173
3-3-3	Molasses	10.509	61.117	57.433	71.423	69.190	62.802
			Cow 860†				
1-1-1	Check		65.152	52.185	66.227	71.731	65.686
2- -2	Molasses	5.138	59.818	48.297	68.706	69.346	61.941
3-3-	Molasses	9.769	61.117	57.433	71.423	69.190	62.802
			Cow 855				
1-1-1	Check		66.120	51.698	74.597	71.050	64.921
2-2-2	Molasses	5.017	62.474	49.963	71.431	75.097	65.773
3-3-3	Molasses	10.670	58.549	53.650	67.813	70.788	61.449
			Cow 1117				
1-1-1	Check		62.649	51.003	71.687	72.461	65.160
2-2-2	Molasses	5.118	59.217	50.389	66.503	73.439	67.975
3-3-3	Molasses	9.806	64.667	54.728	74.814	72.598	66.524

* Cow 848 off feed in Series C—Trial II.

† Cow 860 off feed in Series B—Trial II and Series C—Trial III.

TABLE 6

Average digestibility of the four cows in the three average trials

SERIES	TRIALS	CRUDE PROTEIN	CRUDE FIBER	ETHER EXTRACT	NITROGEN FREE EXTRACT	DRY MATTER
		per cent	*per cent*	*per cent*	*per cent*	*per cent*
1	Check	65.524	50.223	70.857	70.978	64.622
2	Molasses	61.461	51.816	60.529	71.624	61.358
3	Molasses	59.480	47.029	71.991	70.838	63.337

the other two trials it is increased. In the case of crude fiber the greater amount of molasses seems to raise the percentage of digestibility while the smaller amount decreases it. This holds true for each cow.

The variations in the digestibility of ether extract and nitrogen free extract are very irregular and hence these data furnish no evidence as a basis for conclusions.

The digestibility of the dry matter is reduced by the molasses in both trials of cows 848 and 860, whereas it is increased in both trials with cow 1117. Cow 855 shows an increase in trial two and a decrease in trial three.

Still another angle for studying the data is presented in table 6. These average figures were obtained by the method used in computing those of table 5. Table 6 goes just a step further and presents the average of the four cows for each constituent. It is in reality a general summary of all the data.

It is observed that the digestibility of crude protein and dry matter are reduced by both medium and high amounts of molasses. The crude fiber and nitrogen free extract are increased by the medium amount, and decreased by the large amount of molasses, while the reverse of this statement applies to ether extract.

CONCLUSIONS

The data of this experiment indicates that the digestibility of the crude fiber, the nitrogen free extract, and the ether extract is not uniformly affected in either direction by the presence of molasses in the ration. Molasses tends to depress the digestibility of crude protein and dry matter. However, this depression is so slight that it would scarcely be appreciable in ordinary feeding practice.

A more complete and detailed write-up of the experiment will be found in a thesis submitted by the writer for the Degree of Master of Science at the Pennsylvania State College.

REFERENCES

(1) Private correspondence with National Molasses Corporation, Philadelphia, Pennsylvania.

(2) LINDSEY, J. B., AND SMITH, P. H.: The effect of Porto Rico molasses on the digestibility of hay, and hay and concentrates. Massachusetts, 22d Annual Report.

(3) PATTERSON AND OUTWATER: The digestibility of molasses feeds. Maryland Bulletin No. 117, 1907.

CALCULATING THE AVERAGE PRODUCTION OF A DAIRY HERD*[1]

R. B. BECKER

Division of Dairy Husbandry, University of Minnesota, University Farm, St. Paul, Minnesota

The value of a dairy herd today, is measured not so much by the outstanding records of one or two exceptional cows, but rather by the high average production of the entire herd. One or two good individuals may have been purchased, or may even crop out accidentally by a fortunate mating in a large herd of cows. On the other hand, a uniformly high average production indicates more uniform transmitting ability, and measures the value of the cows as members of a breeding herd.

Wide diversity exists between the methods of calculation used in determining the average production of dairy herds. Some of the methods in practise are fairly accurate. Other methods introduce a factor of error, on account of the mathematical means employed in the calculation. No comparison has been made of these methods to date. When herd records are published in the farm press, the lack of uniformity in their calculation has tended to give rise to some confusion, in comparing those not determined on the same basis.

Several different methods of calculation are in vogue at the present time. It is the purpose of this paper to discuss certain of these methods, and to present a more accurate method, recently devised by the author.

Cow testing associations, county breeders organizations, chambers of commerce, dairy extension workers, and others have found it advantageous in the past to evaluate dairy herds under their jurisdiction, according to the average production of all the cows within the herds. These organizations have used four

* Received for publication December 15, 1924.

[1] Published with the approval of the Director as Paper No. 511, Journal Series, Minnesota Agricultural Experiment Station.

methods chiefly. These methods are (1) equivalent average, (2) rough average, (3) herd average with its modifications, and (4) cow-month average.

In order to deal with concrete facts, let us consider an actual herd owned by a member of the Sunflower Cow Testing Associa-

TABLE 1

COW NUMBER	AGE	NOTES	DAYS IN MILK	FEEDING DAYS	MILK	FAT
Cows in N herd during the entire year						
	years				pounds	pounds
2		Grade H	321	365	10,127	408.8
3		Grade H	347	365	10,069	357.9
4		Grade H	281	365	6,452	257.7
5		Grade H	334	365	7,726	307.9
6		Grade H	303	365	8,612	294.8
8		Grade H	321	365	9,027	296.7
9		Grade H	349	365	11,199	439.1
10		Grade H	324	365	11,758	415.9
11		Grade H	319	365	9,468	345.7
17		Grade H	279	365	6,319	237.4
18		Grade H	202	365	5,367	217.6
D	5	Registered H	334	365	10,732	374.3
E	5	Registered H	312	365	10,019	364.5
J	7	Registered H	303	365	8,480	313.1
Cows in N herd part of the year						
1		Culled	133	133	2,449	71.4
7		Culled	dry	95		
12		Died	228	228	4,552	157.8
16		Died	304	304	7,132	333.7
19		Culled	123	140	2,163	107.1
20	2	Heifer	172	172	5,002	194.4
21	2	Heifer	165	165	4,671	158.7
22	2	Heifer	158	158	4,544	147.9
23	2	Died	67	67	2,498	84.6

tion, located in northwestern Kansas. Complete production figures for this herd are tabulated. The records are based upon complete daily milk weights, and a one-day butterfat test each month. Feed, breeding and other records were also kept, but have been purposely omitted from the present discussion. When

feed records are used, they are based upon 365 days feed consumption for each lactating cow, dry periods included.

The fourteen cows completing a lactation period during the year show a total production of 125,355 pounds of milk and 4631.4 pounds of butterfat in 4329 days in milk. Nine remaining cows in the herd of producing age, yielded 33,011 pounds of milk, 1255.6 pounds of butterfat during 1350 days in milk. These nine later cows were of milking age, consumed feed in the herd for a total of 1462 days during the fiscal year. However, only eight of these cows were in milk during the association year. These eight cows consumed feed 1367 days after attaining producing age. Heifers were not considered of producing age until after first calving. The herd of twenty-three cows and heifers yielded a total of 158,366 pounds of milk, 5887 pounds of butterfat during 5679 milking days. Thus we have the herd's total production.

COMPARISON OF METHODS OF CALCULATION

A consideration of the four methods used in the United States in calculating average production of the herd, will now be made, based on data from the above herd.

1. The "equivalent average" method considers the average number of cows milking daily, or monthly, during the year. This figure is secured by dividing 5679 milking days, by 365 days in the year, or 15.8 "cows." Dividing the total production by 15.8 the equivalent average is found to be 10,023 pounds of milk 372.6 pounds of butterfat. Cow testing association records in several states were reported on this basis in the past, using instead the number of months the cows were in milk (omitting the cows dry). This total number of months is divided by 12, to obtain the number of "cows" in milk during the year, when calculating the average production.

Wherein does this method lack?

A casual glance at the records of the individual cows, shows that only four animals in this herd exceeded 372.6 pounds of butterfat. Clearly, the value attained by this method, is an inflated figure which fails to measure the average cow. The

theory upon which it is based, is that a "cow" is milked 365 days during the year. This theory is distinctly wrong, and misrepresents the herd to a considerable extent, especially if the cows are relatively heavy producers during short lactation periods.

As an example, let us compare results of two small herds. Two beef cows milking 4500 pounds of milk in lactations of 180 days each, are equivalent to one "cow" producing 9000 pounds of milk in 360 days, or 9125 pounds of milk in 365 days. This herd production may be compared in the same association, with that of a small herd of two grade Holsteins averaging 7500 pounds of milk each in 310 day lactations. The equivalent average production of these two Holsteins calculated by the same method, would be only 8830.6 pounds of milk.

The mathematics is correct, but is the above basis of comparison fair to both herds? Does it truly represent their relative merits as producers? Does it not rather over-estimate the value of both herds, the short-time producers to a greater extent than the persistent cows?

2. The "rough average" production is obtained by dividing the total production of the herd, by the total number of cows within the herd that have dropped calves prior to, or during the year. In other words, the rough average production of these twenty three cows and heifers is 6885 pounds of milk, 256 pounds of butterfat. This method of calculation has more to recommend it than the equivalent average method. However, it overlooks the fact that cows culled from the herd, or dead during the year, did not pass a normal lactation period. Also, heifers freshening near the close of the year were not given a fair complete measure of their producing capacity. The rough average method somewhat under-estimates the true average production of the herd.

3. The "herd average" method considers only cows that have freshened prior to the first of the year, or that passed a complete lactation in the herd during the year. Fourteen such cows in this herd, calculated upon this basis, actually yielded 8954 pounds of milk, 330.8 pounds of butterfat each.

The herd average method approaches nearer to the actual

condition existing in this herd than either of the two previous methods. If the herd management could be such that every cow within the herd could be included by this method, the true value of the average herd cow would be known. In most herds, however, heifers calve, cows are purchased or sold, or some members of the herd may die during the year. A fair method of calculating the herd's average production should consider these cows, since they are an integral part of the producing herd at least part of the period.

Some modifications of the herd average method vary, in that they include records of cows that have been in milk an arbitrary part of the year. Some of these modified methods set the standard at eight months (244 days), and others at six months (183 days) in order that any records of production may be considered as one lactation. The modifications now in use in the United States, as taken from a recent survey made by the Committee on Cow Testing Associations, will be mentioned later.

4. The "cow-month" method originated at the University of Minnesota as the result of a conference between Dr. C. H. Eckles, E. A. Hanson and G. A. Pond. This method accounts for all cows, both fresh and dry, in the herd each month of the year. This total number of cow-months for the year, divided by 12, gives the number of "cows" in the herd for the year. On this basis the N herd had eighteen cows, which averaged 8798 pounds of milk and 327.1 pounds of butterfat.

This method closely approaches accuracy. However, it gives a slightly inflated average on account of allowing no dry period for heifers freshening near the year's close. Small inaccuracies arise from the use of even numbers of months in determining the cow-months at the beginning and close of a lactation period.

The cow-month method is adapted to field work in cow testing associations where a comptometer is not available for making calculations.

The cow-month method differs only in minor details from the older Danish method to be considered next.

5. The system of computing average production of a dairy

herd as used in Denmark, was evolved by the State Consulent, Axel Appel, for use by the very first cow testing association in 1895. In the Danish system, the herd average production is based upon the number of days a cow consumed feed during the year. The total feeding days of part-time cows, is divided by 365 days to obtain their equivalent number in full lactation periods. Thus, the herd under consideration will be calculated by the Danish method.

Fourteen cows of producing age passed full lactations during the year, and consumed feed for 365 days each. Of the cows in the herd part of the year only, number 7 was not in milk, and hence is discarded entirely. The eight remaining cows and heifers consumed feed 1367 days during or following lactation, during the fiscal year. Dividing 1367 by 365, gives an equivalent of 3.75 full feeding years, or a total of 17.75 full feeding years for the entire herd. On this basis the average production of these 17.75 cows by the Danish method of calculation, is 8922 pounds of milk, 331.7 pounds of butterfat.

The Danish authorities also calculate the average production of the "normal" cows in each herd. The records used in such a calculation exclude all first and second calf heifers, all cows that have aborted, or not bred normally, all animals in any way not passing a normal cycle of lactation and reproduction during the fiscal year. In other words, it is based upon the production records of normal, healthy, mature cows, having 365 days feed records, and a normal lactation during the fiscal year. It measures the ideal production of the breeding cows under the prevailing management.

The Danish method makes no allowance for any dry period in connection with heifers recently fresh, or cows sold while still in milk. In so far as it does this, the calculated average production by the Danish method, tends to be slightly overvalued.

6. To solve the problem of finding a fair standard of comparison between herds, the author devised a sixth method, here termed the "lactation average" method. This method has been in use in the Kansas state institution herds for the past three

years, and has proved satisfactory. The lactation average method is believed to overcome certain defects of some of the previously described methods. Although not perfect, it approaches accuracy more closely than either the equivalent or rough average methods. It overcomes one objection registered against the herd average method, by including all lactating cows and heifers. Although quite similar to the cow-month and Danish methods, it is based upon the length of the average lactation period, instead of on the number of feeding days or cow-months. It allows for a proportionate dry period with cows milking only a part of the year.

Fourteen cows in the N herd passed complete lactation periods during the fiscal year. They averaged 309 days in milk. Considering 309 days as the length of a normal lactation period in this herd, it is found that the nine cows of producing age in the herd only part of the year, are equivalent to 4.37 cows in milk 309 days. In other words, the herd production for the year represents the work of 18.37 full lactation periods of 309 days each (representing present methods of breeding management in this herd). Based on 18.37 full lactation periods, the lactation average production would be 8621 pounds of milk and 320.5 pounds of butterfat.

The lactation average method, as devised, is not above criticism. It assumes that in this particular herd, the part-time producers would average 309 days in milk. This is only approximately true. The three heifers are credited with the highest part of their lactation period. Two of the cows were culled at the close of their lactation period, offsetting to some extent the three heifers. Three cows died from various causes during the year. One cull was fattened and slaughtered for beef, but was not in milk during the fiscal year.

The six methods of calculating the average production, as illustrated with the N herd, give the results as outlined in table 2.

It is seen from the summary of results obtained by applying these six methods to the same herd, that the first result is distinctly an inflated figure. The rough average method is too greatly influenced by a few animals that are members of the

herd only a part of the year. These two methods have gradually been dropped from use, due to the inaccuracies they involve. The herd average, cow-month, and Danish methods show only a small percentage variation, and more closely approach the true figure. The lactation average method, while not perfect, overcomes the small over-valuations arising from not allowing for a dry period with part-time producers. Thus the lactation average, including all individuals, gives the true measure of average production.

A survey made in 1923, brought to light the fact that the equivalent and rough average methods have been practically discontinued from use. Seven states were using the Minnesota cow-month method, with others looking favorably toward it,

TABLE 2

Comparison of results of calculating the average production of herd N by six methods

METHOD	COWS	MILK	FAT
		pounds	*pounds*
Equivalent	15.8	10,023	372.6
Rough	23.0	6,885	256.0
Herd (not modified)	14.0	8,954	330.8
Cow-month	18.0	8,798	327.1
Danish	17.75	8,922	331.7
Lactation	18.37	8,621	320.5

for use in cow testing association work. Fifteen states employed the herd average method. Five of these states used only full twelve month records, one ten months, five nine months, two eight months, one seven months, and one state used all records even of only four months duration when calculating the average production of a herd. The latter, of course, gradually introduce increasing errors in computations involving part-time production records, by that method.

SUMMARY

1. There is lack of uniformity among methods employed in the United States in calculating the average production of herds in cow testing associations. Some of these methods are inac-

curate. A comparison of the results obtained by these methods, has been made on the production records of the N herd of the Sunflower Cow Testing Association in northwestern Kansas.

2. The equivalent average method gives an inflated valuation which is especially increased in herds of cattle yielding a large flow of milk in short lactation periods.

3. The rough average method is too greatly influenced by cows passing only a part of their lactation period in the testing association's fiscal year.

4. The herd average method (unmodified) excludes cows passing only a part of the lactation period during the fiscal year. Yet these cows were an integral part of the producing herd for a part of the year. Modifications of the herd average method introduce an error increasing with the shorter records accepted as full lactation periods.

5. The cow-month method is practically identical with the Danish method. Slightly larger errors may be incurred through use of months rather than exact days. No allowance is made for any dry period with part-time producers, thus slightly overvaluing the herd average. The percentage of error, however, is small by this method.

6. The Danish method bases the number of cows upon feeding days of lactating and dry cows, using 365 days as the standard. It closely approaches accuracy, though tends to over-value part-time cows.

7. The lactation average method is based upon the average length of lactation of the normal cows in the herd, and calculates the remaining part-time producers according to the normal length of lactation of the herd cows.

8. The four last methods named all approach accuracy. Of these, the lactation average method more nearly represents the normal management of the herd, and the true average production.

Acknowledgement is made of the assistance of Mr. Monroe Coleman who performed the actual work of securing production records in the Kansas state institution herds under the direction of the Kansas State Agricultural College during the past three

years. Also to C. R. Gearhart of Pennsylvania State College, and P. C. McGilliard of Oklahoma Agricultural and Mechanical College, who offered constructive criticism of the methods of calculation.

The Danish method was translated and made available for reference in October, 1924, by Consulent K. M. Anderson of Taastrup, Denmark.

REFERENCES

CHRISTENSEN, A. M.: Kontrollaere. Odense, Denmark, 1918.
HANSON, E. A.: Cow Tester's Handbook. Ext. Div., Univ. of Minn.

GELATIN AS A SOURCE OF BACTERIA IN ICE CREAM*

J. M. BRANNON AND P. H. TRACY[1]

Department of Dairy Husbandry, University of Illinois, Urbana, Illinois

Studies have shown that ice cream may be highly contaminated with bacteria. Gelatin, which is used in most commercial ice cream to the extent of about 0.5 per cent, has been considered by some as an important source of contamination. The investigations of Gordon (1), Hammar (2), Ellenberger (3), and Parfitt (4) have shown that the different brands of gelatin vary widely in the number of bacteria they contain.

It was the purpose of this investigation to study the bacteriological condition of gelatin found on the market at the present time (1923–1924) and to determine the importance of this product as a source of contamination of ice cream.

The samples for this study were obtained from eleven leading gelatin manufacturers and distributors and from ice cream manufacturers throughout the state, as well as from a few in Wisconsin and Oklahoma.

The samples from the gelatin manufacturers and jobbers were received in various kinds of containers. It was interesting to note that the container was not a factor in the contamination of the gelatin. Some of the highest, as well as the lowest, counts were obtained on samples that came in sealed envelopes. Likewise, some of the samples which came in such containers as tin cans and sealed card-board boxes were fairly highly contaminated, while others were sterile or nearly so. The gelatin samples obtained from the ice cream manufacturers were secured by send-

*Received for publication November 15, 1924.

[1] This work was suggested and planned, and samples were secured by P. H. Tracy; the bacteriological work was done by J. M. Brannon. The authors wish to take this opportunity to express their appreciation of the coöperative spirit shown by the gelatin manufacturers and jobbers and the ice cream manufacturers from whom the gelatin samples for this study were obtained. Thanks are also due Prof. M. J. Prucha, of the Division of Dairy Bacteriology, for his constructive criticism of the manuscript.

ing them sterile bottles and sterile tin spoons with which to dip the samples.

When a sample of gelatin was taken for bacteriological study a sterile spoon was used for a sampler. The scale pan was covered with sterile paper on which the gelatin was placed when it was being weighed. One gram of gelatin was added to 99 cc. of sterile distilled water which had been heated to 45°C. so as to accelerate the dissolving of the gelatin.

The medium used for growing the bacteria was made of 1.5 per cent agar, 1 per cent peptone, 1 per cent lactose, and a small amount of beef extract. The plates were incubated for five days at room temperature.

DATA

Bacterial counts on the gelatin samples[2]

In table 1 will be found the counts made on different grades of eleven brands of gelatin secured from the gelatin manufacturers and jobbers. It will be noted that the price charged for the gelatin is no criterion of the bacteriological condition of that gelatin. The data show that in general the grades within the different brands run fairly uniform in bacterial count. It is of interest to note that the counts on the samples of 8 of the 11 brands run relatively low, the minimum being 0 and the maximum 396,000, the average of the 38 samples being 30,289. The counts on the other brands are high in several cases.

Counts on samples received from ice cream manufacturers

The counts in table 2 are on gelatin samples received from the ice cream manufacturers. These samples were secured from some of the largest manufacturers in Chicago and Milwaukee, from some of the manufacturers in the smaller cities, and from a few of the small manufacturers in the country towns. Here again it will be noted that in general a high gelatin cost does not necessarily mean a low bacterial count. It is also interesting to

[2] In this discussion, unless otherwise specified, the count on gelatin refers to the number of bacteria per gram of dry gelatin.

TABLE 1

The bacterial counts on gelatin samples received from the gelatin manufacturers and jobbers

Bacteria per gram

PRICE PER POUND	NO PRICE GIVEN	$0.25–.29	$0.30–.34	$0.35–.39	$0.40–.44	$0.45–.49	$0.50–.54	$0.55–.59	$0.60–.64	$0.65–.69	$0.70–.75
brand											
A						Sterile	Sterile		Sterile	100	
B			396,000	201,500	250,000		1,700	500	200	8,000	
C					500	Sterile	100	Sterile	Sterile		
D				3,672,500	6,100,000		1,062,000	338,000			
E			5,500			500	20,200		Sterile	1,200	
F						29,500	800	3,500	1,000		
G							7,000	Sterile	700		
H*		357,500	286,400	715,000	2,697,500	2,398,500	2,860,000	13,000,000	3,500	1,443,000	149,500
		298,000		8,125,000	3,103,500	62,600	31,500	87,000	1,286,000	3,500	
				12,465,000	1,449,500	42,000,000	1,100	3,840,000			
					3,250,000				4,000		
									257,000		
I		7,600	9,000	20,700	83,000	3,800	20,300		3,400	6,800	47,600
						12,500					
J	2,600										
	700										
	3,900										
	600										
K	310,000										
	640,000										
	1,360,000										
	600										

* Jobber.

TABLE 2

Counts on gelatins received from ice cream manufacturers

BRAND*	PRICE REPORTED (CENTS PER POUND)	BACTERIA PER GRAM
B-1	46	1,020,000
B-1	55	1,080,000
B-1	50	5,000
B-1		2,100
B-2	51	103,000
B-2	50	37,400
B-2		1,000
B-3	60	165,000
B-3		1,300
B-4	65	1,700
B-4		2,100
B-5		150
F-1	48	1,200
F-1	55	5,000
F-1	49	1,800
F-1	51	340,000
F-2	60	300
J-1		Sterile
J-2		300
J-3	63	500
J-3		3,800
L	42	7,000
M	56	2,500
N	52	410,000
N	42	280,000
O	42	2,000
O	42	4,000
P	51	Sterile
Q	25	Sterile
R		10,100
R		7,600
S		11,500,000
S		250,000
T		560
U		500
U		1,970,000
V	55	1,250,000

* The sub-number refers to the grade.

note the relatively large number of low count gelatins recorded in the table. Of the 37 samples, 3 were sterile, 21 had a count between 100 and 10,000, 8 had a count between 10,000 and 500,000, and only 5 had a count above 1,000,000.

The uniformity of the bacterial count of gelatin

To determine the uniformity of the bacterial count of gelatin, samples of some of the brands were obtained at different times. These counts are given in part 1 of table 3. In grade 4, shipment 2, under brand A, will be found a count which is much higher than that on the other samples of this brand. The writers cannot account for this great difference since two other samples of the same grade ran low in bacteria.

In addition, a comparison was made of the counts of gelatin received from the gelatin manufacturers and of the counts of similar brands sent in by the ice cream manufacturers. These counts are given in part 2 of table 3. It will be noted that in a few cases there is a wide variation in the counts, but in general the number of bacteria in the different gelatin samples of the same brands compare favorably. Of course it is not known whether the lots of gelatin were manufactured at the same time or were from different runs.

The importance of the gelatin preparation

Gelatin is added to the ice cream mix in either a dry or dissolved form. The method used depends a great deal upon the plant equipment and the general procedure followed in preparing the mix. When added dry, the gelatin is ordinarily sprinkled into the cold mix before pasteurization. When the gelatin is added in a dissolved form it is usually heated in a container in a hot water bath, in a milk can by the introduction of steam, or in a steam jacketed kettle especially made for the purpose. The temperature to which the gelatin is heated and the time it is held naturally vary among different ice cream makers.

Ellenberger (3) found that the temperature to which the gelatin was heated was an important factor in the destruction of

TABLE 3

Counts on different samples of the same brands*

Part 1

BRAND A				BRAND B		
Grade	Shipment 1	Shipment 2	Shipment 3	Grade	Shipment 1	Shipment 2
1	Sterile	200	500	1	396,000	500
2	Sterile	500	200	2	210,500	900
3	Sterile	250	800	3	250,000	12,000
4	100	1,130,000	500	4	251,700	15,000
				5	500	31,000
				6	200	38,000
				7	8,000	41,000

Part 2

BRAND	SAMPLES FROM GELATIN MANUFACTURERS	SAMPLES FROM ICE CREAM MANUFACTURERS
F-1	3,500	5,000
		1,200
		1,800
		340,000
F-2	1,000	300
B-1	1,700	1,020,000
	41,000	1,080,000
		5,000
		2,100
B-2	34,000	103,000
	58,000	37,000
	500	1,000
B-3	12,000	1,300
	15,000	165,000
	200	
B-4	900	1,700
	8,000	2,100
B-5	500	150
J-1	2,600	Sterile
J-2	700	300
J-3	3,900	500
		3,800

* Number of bacteria per gram.

the bacteria. He reports that the average total count, for the 15 samples of gelatin studied, when dissolved at a temperature of from 125° to 130°F, was 388,162; when dissolved at a temperature of 160° to 170°F. the average was 1172, and when dissolved in boiling water the average count was reduced to 530.

TABLE 4

Relation of the method of preparing the gelatin to its bacterial count

Part 1

DATE PLATED	COUNT PER CUBIC CENTIMETER OF RINSE WATER ADDED TO UNWASHED PAN	TEMPERATURE TO WHICH HEATED	COUNT AFTER BEING HEATED (PER GRAM)
May 21		180°F.	800
May 22		140°F.	900
May 26	55,000	180°F.	900
May 28		150°F.	900
June 3		160°F.	2,450
June 6	1,700	160°F.	900

Part 2

DATE HEATED	COUNT PER CUBIC CENTIMETER OF RINSE WATER ADDED TO UNWASHED PAN	COUNT OF RAW SKIM MILK IN WHICH GELATIN WAS TO BE DISSOLVED	TEMPERATURE TO WHICH HEATED	COUNT OF HEATED SKIM MILK WHEN RAISED TO DIFFERENT TEMPERATURE	COUNT PER GRAM OF GELATIN HEATED IN SKIM MILK SOLUTION	COUNT PER GRAM OF GELATIN HEATED IN A WATER SOLUTION
September 19			140°F.			250
September 20	900	700,000	150°F.	600,000	3,600	850
September 23	110,000		150°F.			330
September 26	28,200	10,000	160°F.	3,300	700	270
September 28	5,000	480,000	170°F.	2,000	1,500	210
October 1	700		160°F.			170
October 3	4,800	450,000	140°F.	163,000	1,820	600
October 6	600		160°F.			150
October 10	2,100		160°F.			440

The counts in column six (6) were obtained by substracting the count on the heated milk from the count secured from heated milk and gelatin.

To determine the importance of the care given the gelatin cooker and the effect of the heating process upon the bacterial count of the gelatin, the following experiments were conducted:

May 21 a liter of a ten per cent solution of a gelatin having a

count of 5000 bacteria per gram was heated to 180°F. in a 2-quart aluminum double boiler. The count was reduced to 800 per gram. The gelatin pan was emptied and allowed to remain unwashed at room temperature until the next day when a fresh supply of the gelatin solution was added to the pan and heated this time only to 140°F. The count per gram of gelatin was 900. The operation was repeated and, in addition, the gelatin pan, after standing twenty-four hours unwashed, was first rinsed with 99 cc. of sterile distilled water. This rinse water contained 55,000 bacteria per cubic centimeter (see table 4, part 1, column 2) and the gelatin after being heated contained 900 bacteria per gram. This experiment was continued until June 6, the results being shown in table 4.

Since the gelatin used in the experiment recorded in part 1 of table 4 was low in bacteria, the experiment was repeated using a gelatin which had a count of 6,100,000. The results are given in part 2 of table 4. Part 2 also includes the counts obtained on gelatin dissolved in skim milk.

In another experiment, conducted during the hottest part of the summer, an unwashed gelatin pan stood for forty-eight hours at room temperature, during which time the gelatin liquified. Ninety-nine cubic centimeters of sterile distilled water was added and a count of 1,988,000,000 bacteria per cubic centimeter was obtained from the rinse water. Then a ten per cent gelatin solution was added to the pan and heated to 166°F. and the gelatin plated. The count secured was 6180 per gram (the original gelatin containing 300 bacteria per gram) an increase of nearly 2000 per cent in the count.

Although it might be considered desirable from a bacteriological standpoint to heat the gelatin solution to a high temperature, it should be remembered that too high a temperature is likely to injure the jellying qualities of the gelatin. The effect of increased temperature upon the strength of a 3.5 per cent solution of high grade gelatin is shown in table 5. The samples were prepared by dissolving the gelatin at 125°F. and then adding it to tin cans which after being sealed were heated in hot water at the indicated temperature for thirty minutes, taking about ten

minutes for the water to reach that temperature. The cans were then removed to the 40°F. storage room and held for a period of fifteen hours. They were then held at room temperature for six hours, when they were opened and the jelly strength determined by means of a tester of the type used by the Forest Products Laboratory at Madison, Wisconsin.

While the above relation of temperature to jelly strength probably would not hold for all gelatins it shows the tendency for the higher temperatures to weaken the strength of the gelatin. For this reason the gelatin solution should not be pasteurized at too high a temperature.

TABLE 5

Relation of temperature to jelly strength

TEMPERATURE	JELLY STRENGTH (DEPRESSION IN CENTIMETERS)
140°F.	1.725
160°F.	1.75
170°F.	1.80
180°F.	1.85
190°F.	1.925
200°F.	2.65
Boiled	Too weak to measure

Autoclave—12 pounds pressure 50 minutes—liquid-like water.

Relation of condition of storage to the number of bacteria in gelatin

To determine the importance of the condition under which gelatin is held, six Sealright pint containers were filled with gelatin and stored under the different conditions indicated in table 6. The samples were placed April 16 and counts were made at different intervals between that date and October 24. The difference in the humidity of the rooms in which the gelatins were stored resulted in a difference of moisture content as shown in the table.

DISCUSSION

The data presented in tables 1, 2 and 3 indicate that it is possible to manufacture gelatin that is practically sterile. Twelve of the 142 samples examined were free from germs. In general

TABLE 6

Relation of the condition of storage to the bacterial count

DATE OF COUNT	COUNT
A. 0° to 10°F. storage room (dry)	
May 1	1,400
June 12	1,300
July 15	2,400
September 1	1,700
October 24	800
Percentage moisture September 13 = 13.5	
B. 90° to 100°F. storage room (dry)	
May 3	700
May 23	300
June 12	450
July 15	1,200
September 1	500
October 24	550
Percentage moisture September 13 = 12.05	
C. 30° to 40°F. storage room (damp)	
May 1	1,000
May 23	1,500
June 12	1,500
July 15	1,000
September 1 (sample had become lumpy)	4,000
October 24	41,000
Percentage moisture September 13 = 30.22	
D. 30° to 40°F. storage room (in desiccator) (dry)	
May 1	3,400
May 23	4,200
June 12	2,000
July 16	4,800
September 1	3,700
October 24	1,000
Percentage moisture September 13 = 11.76	
E. 65° to 75°F. storage room (damp)	
May 23	2,400
June 12	500
July 15 (sample had become lumpy)	10,000
September 1	17,700
October 24	115,000
Percentage of moisture September 13 = 25.09	

TABLE 6—*Continued*

DATE OF COUNT	COUNT
F. 85° to 100°F. storage room (dry)	
May 1	5,000
May 23	2,000
July 16	3,700
September 1	700
October 24	700
Percentage moisture September 13 = 12.64	

the samples ran low in bacteria, since fifty per cent of them contained less than 20,000 bacteria per gram, whereas only thirty-one per cent (nearly one-half of which were of the same brand) contained over 100,000 bacteria per gram. It is apparent that many of the gelatin manufacturers are producing gelatin of low bacterial count.

Samples of some of the brands ran uniformly low in bacteria while the samples of other brands were much more highly contaminated. It might be inferred from this that the method of manufacture is a very important factor in the number of bacteria present in gelatin.

The heating of gelatin to 140° to 160°F. greatly reduces the number of bacteria present, even though the gelatin may be highly contaminated. The efficiency of pasteurization seems to be greater in a water solution than in a skimmilk solution.

It is evident that neglecting to clean the gelatin cooker after it is used will increase the bacterial contamination from gelatin. The importance of this factor depends somewhat upon the temperature and humidity of the room in which the gelatin cooker is placed.

It does not seem likely that the bacterial count of gelatin increases to any extent after the gelatin leaves the manufacturer unless it becomes damp or is contaminated by some foreign material. Some observations by the writers confirm this opinion. There were in the laboratory two uncovered kegs of gelatin. In April counts were made on both of them. One had a count of 300 and the other had a count of 5000. During the summer several counts were made of the first gelatin and each time it

gave a count of 300. Three counts were made of the second gelatin obtaining 5000, 8000, and 5000 bacteria per gram, respectively. The first of these counts was made in April, the second in July and the last in September. These kegs were kept in a dry place. The results in table 6 also suggest that there is not much change in the bacteria content of the gelatin if it is kept dry.

From the data obtained in this investigation the writers conclude that the addition of gelatin to commercial ice cream results in a very slight increase in the number of bacteria.

REFERENCES

(1) GORDON, JOHN: Ice cream sanitation, VI. The Ice Cream Trade Journal, viii, 32–34.

(2) HAMMER, B. W.: Bacteria and Ice Cream. Bulletin 134, Iowa Agriculture Experiment Station.

(3) ELLENBERGER, H. B.: A study of bacteria in ice cream during storage Memoir 18, Cornell University Agriculture Experiment Station.

(4) PARFITT, E. H.: Study of gelatin for the manufacture of ice cream. The Ice Cream Review, vii, 58.

THE EFFECT OF SEASON ON THE MILK AND FAT PRODUCTION OF JERSEY COWS*

C. ELMER WYLIE

Department of Dairying, University of Tennessee, Knoxville, Tennessee

It is a well established fact that the milk flow of a cow tends to decrease as the period of lactation advances and that the per cent of fat in the milk tends to increase during the same period. Recent investigations have shown that the season of the year also has an important relation to the amount and richness of milk which a cow produces. The work of Eckles (1) Erf and Cunningham (2) Ragsdale and Turner (3) and Wylie (4) shows that there is a tendency for the percentage of fat in cows' milk to be low in summer and high in winter.

It is important therefore to determine the combined effect of the period of lactation and the season on the milk production of cows. It is the purpose of this paper to show how season affects the production at the same time making a true allowance for period of lactation. The records used in making this determination were more than 2900 individual Register of Merit Records of Jersey cows furnished by the American Jersey Cattle Club for cows freshening in the year 1921 throughout the United States.

Figure 1 shows the average daily production of milk for all cows regardless of the time they freshened. This shows that the high production of milk was 27.2 pounds daily average for June and that this gradually declined to November with an average daily production of 22.8 pounds of milk. From November there was a gradual incease to June.

Table 1 shows the average per cent test of fat by months for cows according to the month in which they freshened. It will be noted that the cows which freshened in January averaged 4.89 per cent fat for that month. There was a gradual increase

* Received for publication October 25, 1924.

from this until the sixth to eighth month when there was only slight variation followed by a rise at the end of the lactation period. The cows which freshened in June changed but little

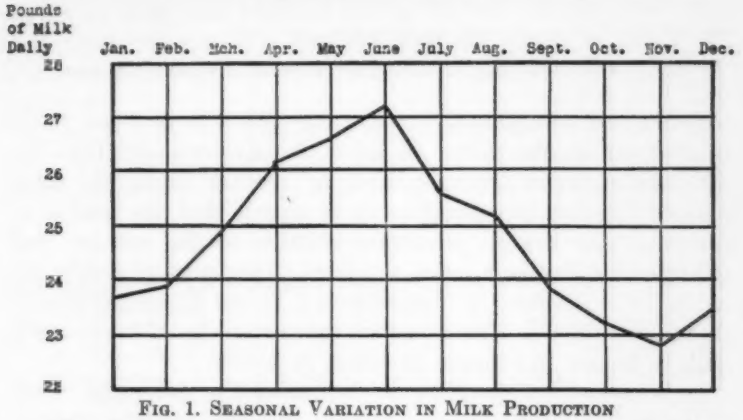


FIG. 1. SEASONAL VARIATION IN MILK PRODUCTION

Table compiled by Paul Reaves, senior student in Dairying, 1924, University of Tennessee.

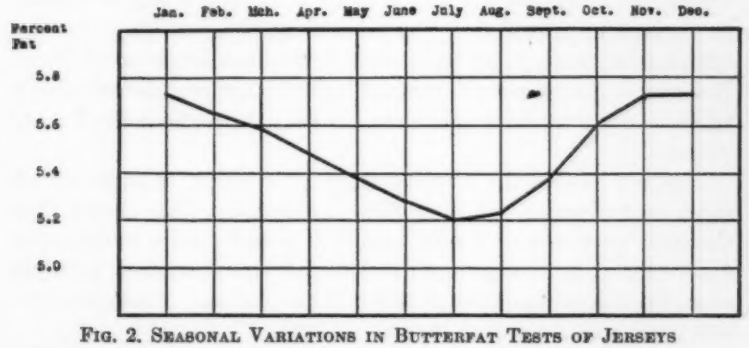


FIG. 2. SEASONAL VARIATIONS IN BUTTERFAT TESTS OF JERSEYS

Table compiled by T. G. Hinton, senior student in Dairying, 1924, University of Tennessee.

after the sixth month. The cows which freshened in July tested highest in the seventh month or January. In practically all other cases the highest tests occurred at the end of the lactation period.

TABLE 1*

Average per cent of fat according to month in which cows freshen

MONTH COW FRESHENED	NUMBER OF COWS	MONTH OF LACTATION												
		1	2	3	4	5	6	7	8	9	10	11	12	13
January	326	4.89	4.93	4.95	5.06	5.20	5.07	5.07	5.15	5.44	5.73	5.93	5.90	5.95
February	323	4.71	4.93	4.96	5.03	5.06	5.03	5.10	5.40	5.70	5.96	5.81	5.96	5.80
March	326	4.88	4.93	5.03	5.07	5.06	5.29	5.51	5.89	6.07	6.16	6.19	6.27	6.21
April	330	4.84	4.86	4.89	4.89	5.07	5.36	5.71	5.90	5.95	5.98	5.97	6.02	6.03
May	323	4.76	4.76	4.82	4.97	5.22	5.72	5.88	5.93	6.05	5.97	5.91	5.85	5.71
June	225	4.63	4.63	4.87	5.15	5.57	5.73	5.82	5.88	5.86	5.86	5.80	5.84	5.93
July	125	4.73	4.76	5.07	5.46	5.75	5.89	6.03	6.01	5.93	5.85	5.87	5.82	5.86
August	151	4.65	4.79	5.15	5.48	5.71	5.78	5.74	5.83	5.72	5.64	5.64	5.68	5.88
September	211	4.79	5.01	5.28	5.60	5.76	5.79	5.74	5.64	5.63	5.50	5.57	5.75	5.89
October	197	4.95	5.11	5.32	5.63	5.68	5.61	5.58	5.60	5.47	5.55	5.61	5.86	6.16
November	200	5.01	5.13	5.35	5.52	5.52	5.51	5.43	5.41	5.38	5.52	5.79	5.87	6.29
December	167	5.07	5.13	5.25	5.36	5.45	5.46	5.38	5.39	5.43	5.78	6.05	6.21	6.27

* Table compiled by T. G. Hinton and H. W. Arnold, senior students in Dairying 1924, University of Tennessee.

TABLE 2*

Average yearly milk and fat production according to month in which cows freshen

MONTH COW FRESHENED	NUMBER OF COWS	MILK	FAT	FAT
		pounds	*per cent*	*pounds*
January	325	8857.86	5.30	470.15
February	337	8859.84	5.31	471.13
March	325	8828.65	5.35	472.80
April	331	8700.05	5.31	462.61
May	323	8787.00	5.33	468.79
June	225	8759.16	5.39	472.92
July	125	8952.89	5.47	489.97
August	151	8566.80	5.39	462.08
September	211	8652.97	5.45	472.35
October	196	8825.85	5.45	481.28
November	200	8900.29	5.38	479.40
December	167	8853.18	5.38	477.11
Average		8796.12	5.39	473.89

* Table compiled by T. G. Hinton and H. W. Arnold, senior students in Dairy 1924, University of Tennessee.

Figure 2 shows the average per cent of fat for all cows for the various months, regardless of the time they freshened. The

highest tests were for November to January inclusive with an average of 5.73 per cent fat. There was a very gradual decline in test from January to July the lowest month with an average of 5.2 per cent fat and this was followed by a more rapid increase in November.

Table 2 shows the yearly production of cows freshening at the various months of the year. The cows which freshened in January averaged 8857 pounds of milk containing 470 pounds of fat with an average test of 5.30 per cent. The highest milk production was for the cows freshening in July with an average of 8952 pounds containing 489 pounds of fat with an average of 5.47 per cent fat. November was the next highest in milk production but October was the second highest in fat production. The lowest production was 8566 pounds of milk containing 462 pounds of fat with an average test of 5.39 per cent fat for cows freshening in August. There were 337 cows which freshened in February, the largest number for any month while the lowest was 125 for July.

The cows which freshened in January averaged 5.30 per cent the lowest, while the cows which freshened in July averaged 5.47 per cent fat the highest for the entire lactation period. The increase in test of the latter was 0.17 per cent fat higher than the lowest month. The difference between the high and low months in milk production was 386 pounds. The difference between the high and low months in fat production was 27 pounds.

SUMMARY

A study of more than 2900 Register of Merit Records of Jersey cows showed the following:

1. The cows which freshened in May and July gave the richest milk on the average in the ninth and seventh month respectively of the lactation period. The cows which freshened in June averaged a higher test of fat for the eighth to tenth month in period lactation than they did in twelfth month. The average per cent of fat in the milk, for a year for cows freshening in July, September, and August was the highest, being at least 5.45 per cent.

2. The yearly milk production was highest for the cows freshening in July, October, November, December, January, February, and March, all being over 8800 pounds. April, May, June, August, and September were the low months, although on the average the difference between the two groups was not great.

3. The yearly fat production averaged the highest for cows which freshened in July, October, November, and December, all being above 477 pounds of fat. April, May, and August were the low months all being below 468 pounds of fat. The cows which freshened during the month of July averaged 27 pounds of fat more than those which freshened in April and August.

4. The season of freshening as well as the period of lactation affects the richness of milk from a cow. The richest milk may be produced at some time before the end of the lactation period depending on the month in which the cow freshened.

REFERENCES

(1) Eckles, C. H. 1923 Dairy Cattle and Milk Production, p. 406.
(2) Erf and Cunningham 1915 Dairy Fundamentals, p. 9.
(3) Ragsdale and Turner 1922 The seasonal variation of the per cent of fat in cows' milk. Jour. Dairy Sci., v, no. 6, 544.
(4) Wylie 1923 Factors influencing two-day official butter-fat tests of cows. Jour. Dairy Sci., vi, no. 4, 292.

TREATMENT OF CREAM FOR THE REMOVAL OF OBJECTIONABLE FLAVORS AND ODORS[1]

O. F. HUNZIKER

Blue Valley Creamery Company, Chicago, Illinois

IMPROVEMENT OF QUALITY OF CREAM RECEIPTS MOST FUNDAMENTAL

In discussing the subject of removing objectionable flavors and odors from cream, it should be understood at the outset that whatever treatment is given the cream in the factory is not meant to excuse or condone the production of cream of poor quality, nor are such efforts to remove flavor defects offered as a substitute for efforts of cream improvement on the farm through greater cleanliness, better care, and more frequent delivery by the producer. There is no substitute for the production of better cream.

Poor quality of cream is the curse of the industry and all efforts to eliminate its production should be encouraged by every means at our disposition. The relatively small volume of inferior cream and the general good quality of the cream receipts last spring and early summer gave promise that last year's efforts of the creamerymen at cream-grading and quality-paying were beginning to show concrete results in the form of better cream. During the hot weather months, however, the quality of the cream in the southern tier of the middle-west suffered a most discouraging slump. This suggests that the cool weather early in the season was probably largely responsible for the good quality of cream received at that time and that the difficult task of permanent cream improvement is by no means solved yet and still demands the concentrated effort of all agencies interested in the quality of American butter.

Our greatest drawback in the middle-west is the relative

[1] Address at Annual Meeting of American Dairy Science Association.

scarcity of cow population. In large areas of the corn belt there are but few cows to the farm and the milking of cows is a mere side-line of general farming. A few cents more for better cream does not mean much in farm income to the farmer who has but little cream to sell. The difference in market price between good and poor butter is not sufficient to induce him to keep obnoxious weeds out of his pastures and to divert more time from his general and principal farm work to extra care and more frequent delivery of his cream, in order to secure the top price from the creamery that buys cream on the quality basis. This applies especially wherever coöperation among competing creameries is lacking and where the farmer, therefore, can find a profitable market for his cream regardless of inferior quality.

In the more highly developed dairy sections, as in Minnesota, Wisconsin, parts of Iowa, and the Pacific Coast States, conditions for cream improvement are far more favorable and the possibilities for cream of uniformly good quality are practically assured. The herds there are larger and contact between creamery and patron is more direct and closer. The farmer is a dairyman whose dominating business is to milk cows; he produces a larger quantity of cream and every additional cent he can get for cream of better quality means a worthwhile increase in his farm income. It pays him to spend the extra time and labor necessary to meet the requirements of the creamery that pays for quality.

There is no question that if all creameries paid for cream on the quality basis cream improvement would be an established fact. One hundred per cent coöperation among competing creameries would wipe out the only profitable market available for cream of poor quality. The producer then would have to produce better cream or quit selling cream altogether. This ideal is sound but, so far, it has fallen short of successful, practical application, particularly in the corn-belt states.

MUST MAKE BEST OF EXISTING CONDITIONS

I repeat that the fundamental efforts toward permanent improvement of American butter must ever be centered on means to *prevent* the production of inferior cream. Our organi-

zation has been, is now, and will continue carrying on a definite plan of cream-grading and quality paying, both in the form of paying a special price over and above our standard quotations for sweet cream of good flavor and by penalizing the very poorest cream.

Our experience in this work, while hopeful, convinces us of the slowness of permanent improvement under existing competitive conditions. We realize that, even at best, off-flavored cream is likely to continue to arrive at and be received by the creameries. It will be with us for some years to come. We must, therefore, resort to remedies as well as means of prevention; remedies that will pick up the threads of cream improvement where inadequate prevention has dropped them. We must try to undue the defects which it was beyond our control to prevent, as far as such remedy is physically possible and consistent with pure food laws and regulations. We must avail ourselves of every legitimate means that science and practical experience provide to remove such objectionable flavors and odors as may be present in the cream at the time we receive it.

CLASSIFICATION OF OFF-FLAVORS IN CREAM

The ease or difficulty with which objectionable flavors and odors may be removed from cream varies greatly and depends principally on their origin. It seems logical, therefore, for the purpose of this discussion, to group the multitude of flavor defects according to the causes that produce them.

1. Feed and weed flavors. The most prominent among these, from the standpoint of their detrimental effect on the market value of the butter are, wild onion, garlic, leek, and French weed. Other pronounced, though less intense off-flavors of this group are sweet clover, turnip, mustard, potato, etc. Most of these feed and weed flavor defects are local and seasonal. While they do not appear everywhere, nor the year around, they are very common in certain localities and appear at their chosen season with exasperating regularity. While they last they are a menace to the industry, often dropping the market

value of butter that is impregnated with them to a point that means heavy financial loss to the creamery.

2. Flavors absorbed from surroundings. These flavor defects are not so common. They appear spasmodically and generally only in isolated cases, but their presence in butter is very objectionable. Among the better known of these are oily, gasoline, kerosene, and diverse vegetable flavors. They usually occur where cream is stored in close proximity to materials of which they are an inherent part. The oily flavor is often traced to faulty conditions surrounding the operation of the cream separator as, for instance, the use of too much separator oil around the bearings and spindle and operating the machine without having the bearing guards in place. This frequently causes the oil to be plastered over the separator frame and the nearby wall, saturating the air with the odor of separator oil, for which odor the cream appears to have a marked affinity. The operation of a gasoline engine in the separator room without proper exit for the exhaust will give the cream, almost invariably, a gasoline flavor. The storing of the cream in the basement, or similar places on the farm, where vegetables are kept or potatoes are sprouting, usually impregnates such cream with the respective vegetable flavors and odors, etc.

3. Flavors due to contamination of cream with foreign substances. These cases of off-flavors are purely local but their occurrence at times is menacing and costly to the creamery. Among these cases, gasoline, kerosene, and metallic flavors are the most common. Investigation shows that occasionally the railway station agent or the farmer himself is using the empty cream shipping cans as a carrier of gasoline and sometimes of kerosene and remnants of these liquids are left in the can at the time it is filled with cream. The use of milk utensils, such as dippers and pails, for transferring kerosene has also been found responsible for kerosene-flavored cream in some instances, etc. Metallic flavor is often attributable to rusty cans, but has also been found to result from bacterial contamination.

4. Flavors due to bacterial contamination and fermentation. This obvious, well-known and very common source of flavor

defects leads to a great variety of off-flavors, the type and intensity of which are largely controlled by the relative standard of cleanliness of cream production, the temperature at which the cream is held on the farm and in transit, and the age of the cream when it reaches the creamery. The most common individual flavors of this group are, stale, cheesy, metallic, yeasty, bitter, high acid. It is not necessary here to discuss cause and effect of this group; the subject is well known to all of you, except possibly to emphasize that age is the greatest factor of them all, as it intensifies the detrimental effect of any condition adverse to good flavor to which the cream may have been exposed.

DEVELOPMENT OF METHODS TO REMOVE OBJECTIONABLE FLAVORS AND ODORS FROM CREAM

For many years the possibilities of freeing cream intended for butter making from flavor defects have been subjected to experimentation and study. The records of the patent office show numerous patents granted on equipment and methods to improve the flavor of milk and cream. The fundamental principle of most of these inventions has to do with exposure of milk and cream to air either by passing air over thin layers of the liquid or by blowing air through the body of the liquid, and in some of the later processes the treatment has shifted from air treatment to vacuum treatment. The temperature of the cream during treatment varies with each invention ranging anywhere from room temperature or lower to the boiling point of water. Most of these designs and processes have merit and each one of them would probably be helpful in removing at least a limited portion of off-flavors present. But in the face of our own experience in trying out the possibilities and limitations of flavor-removing apparatus and processes, we are forced to conclude that most of these inventions are entirely inadequate to remove from cream, completely, such intense and stubborn off-flavors as wild onion, garlic, and the like. Furthermore, the mechanical phase of many of these inventions precludes their adaptability for treatment of commercial cream intended for butter making. It is probably for these and similar reasons that the great majority

of these inventions have never passed beyond the stage of theoretical patent designs and hypothetical descriptions and that they have failed to receive the serious consideration of the industry for which they were obviously intended.

You may recall that about fourteen years ago a wave of blowing cream with air swept the middle-west. Creamery supply houses placed on the market complete units for blowing air through the cream in cream-ripening vats and the use of these units became very popular. It took several years of practical experience to establish the fact and to convince the users that the results obtained with that equipment were disappointing and did not justify the expense of its installation and operation. The principle of aeration was sound enough but the method applied was utterly inadequate and incapable of removing enough of the objectionable flavors to accomplish visible improvement of the quality of the resulting butter.

In 1914 Ayres and Johnson (1) published experimental results on removing onion flavor from sweet milk and sweet cream. While their experiments were confined to sweet milk and sweet cream only and conducted on a laboratory scale, their work was a vast step in the right direction. They found that the successful removal of onion flavor required far more intensive air treatment than had heretofore been employed.

In 1920 the market was flooded with an exceptionally large volume of butter with garlic and wild onion flavor. This caused an unprecedented slump in the market value of butter containing these strong off-flavors. Onion-flavored butter sold at prices as low as twenty cents under Extras. It was at that time that the Blue Valley Research Laboratory undertook an extensive investigation, the purpose of which was to subject all onion and garlic-flavored cream to such treatment as would make possible the manufacture of butter free from these disastrous flavor defects. Our treatment consisted of passing heavy currents of filtered air through a spray of cream in several directions for a prolonged period of time. The cream was kept hot by recirculating it continuously through a flash pasteurizer. Before treatment the cream was standardized to a definite point of

acidity to forestall serious interference from abnormal curdling during treatment.

Our early experiments demonstrated that it was possible to remove every vestige of onion flavor from sour cream by continuing the treatment long enough. But we soon came to realize that to subject commercial cream to such violent treatment involves several complex and seemingly evasive physical and mechanical problems that affected the texture of the resulting butter. The chief difficulty was the tendency of the cream to churn in the vats and the appearance of a pronounced mealy texture in the butter. Using heated air in the place of recirculating the cream through the flash pasteurizer and adopting a practical system of flash-cooling materially reduced these tendencies.

This system was in operation successfully for two years in one of our factories and for one year in two more factories. It not only did away with onion-flavored butter but it proved very helpful in improving cream with other off-flavors.

Its greatest drawback was the time required for treatment and the constant danger of jeopardizing the texture of the butter. Our efforts, therefore, were directed towards a modification of this process, that would produce equally good results in removing off-flavors in a shorter time and thereby insure with greater certainty the preservation of normal texture of the butter. These efforts led to the conception of operating the air treatment in a partial vacuum confined in a glass-lined container. So, in conjunction with the Pfaudler Company of Rochester, N. Y., an apparatus was developed to accomplish this. This apparatus is now manufactured and sold by the above company under the trade name "Pfaudlerizer" and both apparatus and process are covered by patents held by the Pfaudler Company. The Pfaudlerizer consists of a jacketed vacuum pan, constructed of glass-lined steel, equipped with an arrangement for breaking the cream up into a fine spray and with fittings that make possible the recirculating of the cream during treatment. It has an intake also for the heated air and an impeller for agitating the cream.

OPERATION OF THE PFAUDLERIZER

After standardizing the cream for acidity and adding to it an amount of water approximately equal to that evaporated during treatment, the cream flows through flash pasteurizers and enters the vacuum pan in the form of a fine spray. While the cream enters the pan a vacuum of from 20 to 24 inches is maintained. When the cream is all in, it is caused to circulate by pumping it from the bottom of the pan back through the jet in the top. At the same time, heated air is blown into the pan in sufficient quantities to reduce the vacuum to about 7 inches while the vacuum pump is in continuous operation. When all of the removable flavors are expelled, as is readily determined by taking samples of cream at intervals, the circulation is stopped, the air blast is shut off, and the vacuum is once more raised to 20 inches or above in order to remove excess air.

The vacuum is then broken and the cream is pumped through a flash cooler into the holding tank. Our aim is to have it enter the holding tank at as near churning temperature as possible so as to obviate the necessity of prolonged cooling and agitation. The time of treatment depends entirely on the quality of the cream. Cream with only slight off-flavors is held in the pan for a short time only, or is flashed into and through the pan and is pushed through the cooler into the holding tank in one continuous operation. In the case of garlic cream and cream pregnant with other intense off-flavors, it is given the circulating treatment in the presence of the air blast as long as is necessary in order to accomplish maximum improvement. This may be from 15 to 30 minutes or even slightly longer.

EFFECT OF TREATMENT ON FLAVOR

It should be understood that this process is capable of removing flavors only that are volatile or volatilizable under the conditions of operation. Many of the most objectionable weed and feed flavors are of this nature, and as previously stated, such off-flavors as wild onion, garlic, and similar weed and feed flavors, are removed completely so that not a vestige of them is

detectable in the butter. Our experience has demonstrated that much of the weed-flavored cream is otherwise good cream and when these flavors are removed a very good piece of butter results.

Flavors absorbed by the cream from outside environment, such as oil, gasoline, and diverse vegetable flavors, as explained under off-flavors belonging to group 2, also yield successfully to this treatment, but when gasoline and kerosene flavors are due to gasoline or kerosene having been added to cream, accidentally or otherwise, as discussed under off-flavors in group 3, their complete removal is more difficult.

Fermentation flavors that are volatile are removed, but in most cases of advanced fermentation the production of volatile flavors is accompanied by the formation of other, non-volatile flavor products. These non-volatile off-flavors do not respond to this treatment nor to any other treatment known. What has been torn asunder by the relentless tooth of nature's processes cannot be reassembled and returned to its original state by mere mechanical juggling. Fermentation that means a partial breaking down of the fats or proteins of milk and cream places these products beyond the saving ingenuity of the science of buttermaking. It is for this reason that such off-flavors as rancid, cheesy, old yeasty, bitter, metallic, cannot be removed entirely. The volatilizable portions will escape easily enough, but there remains a residue of objectionable flavors that cannot be removed completely, and that is carried with the cream into the butter.

It is not possible, therefore, to make an Extras from cream that scores Seconds, but it is possible to raise the score of No. 2 cream, improve the flavor of No. 1 cream, decrease the percentage of No. 2 cream, and increase the percentage of butter scoring 90 points and better.

I realize that results expressed in so general terms as the above are somewhat disappointing and that you will logically ask the question, how many points in score is the butter improved by giving this treatment to the cream? This question is somewhat difficult to answer. The specific improvement varies

greatly with the particular character of the off-flavor present in the original cream and a definite answer that shows direct results can only be given by making split churnings, treating one-half and not treating the other half of cream from the same batch.

It is somewhat cumbersome and materially interfering with the efficiency of operation to make split churnings in the routine of commercial manufacture. For this reason data of such direct comparisons are somewhat scarce. In an experiment of seven split churnings or fourteen churnings in all, where we used all the cream received and for the sake of the experiment did not grade out any of the poor cream, the treated cream butter scored 90.3 points while the untreated cream butter scored 89.01 points, a difference in favor of the treated cream butter of 1.29 points. These scores represent the averages of three judges scoring this butter independently and without any knowledge of the origin of the packages before them. Our records of the scores of No. 2 butter show that the factories using the Pfaudlerizer are putting out a butter from 1½ to 2½ points higher in score than they did prior to the use of this equipment and are no longer producing onion-flavored butter. In short, then, this treatment eliminates from cream volatile and volatilizable flavor defects such as weed flavors, absorbed flavors, and flavors produced during the early stages of fermentation.

Such results are not attainable by merely passing currents of air through the body of the cream nor by flashing cream into a vacuum alone. Both of these methods of treatment are capable of removing flavors to a limited extent, but from the standpoint of visible improvement of quality, the results are disappointing. For maximum results and complete removal of such stubborn off-flavors as onion and garlic flavor and the like, the treatment must be more intense, the air must come in contact with a larger surface of the cream and the odor-laden air must be removed quickly and completely. The heat of the cream must be maintained at a temperature at which the objectionable flavors most readily volatilize. This combination of conditions is provided in the apparatus and process above described.

EFFECT OF TREATMENT ON TEXTURE OF BUTTER

The successful removal of flavors and odors present in cream involves the solution of some interesting physical problems. There is a tendency for the cream that has been subjected to this process to churn in the vats and for the resulting butter to have a disagreeable, mealy texture. These defects can be readily and completely prevented by a correct understanding of the physical effect on the fat globules of prolonged exposure of the cream to high temperature and vigorous agitation. While in the early development of this process these difficulties presented a real menace, they have ceased being an important factor; mealiness and premature churning are now a thing of the past.

Scientifically the physical phenomena that enter into this condition require further study. Microscopic examination of the cream at different stages of the treatment show a progressive increase in the size of the fat units. The small fat globules become fewer in number and there is a distinct increase in the size of the average globule. This change begins in the pasteurizer and continues in the vacuum pan. After thirty to forty minutes treatment, the diameter of the average fat unit is many times as large as it was before treatment. The diameter of some of the fat globules increases to the size of 50 to 60 microns and some of the largest fat units show a contorted periphery.

Whether this condition is due to the prolonged exposure to pasteurizing heat, or to prolonged violent agitation of the heated cream, or both, and to what extent the oiling-off tendency of the hot samples of treated cream while waiting for microscopic examination mars the accuracy of these examinations and interferes with the correct interpretation of the results, have not as yet been definitely determined.

It is of interest here to note that Rahn and Mohr (2), who studied the distribution of fat in pasteurized cream, also find a distinct increase in the size of the units of fat in cream due to flash pasteurization. They ascribe the cause of this phenomenon to the agitation of the cream in the pasteurizer, but their report fails to show what would have happened at the same pasteurizing

temperature without agitation or with the same agitation at lower temperature.

Our results and observations are clear on the fact that when cream that has been subjected to this violent agitation in the presence of heat, is permitted to lie undisturbed before cooling or is cooled very slowly, the butterfat oils off copiously and butter made from the cream when in this condition has invariably a very mealy texture. If the cooling is done in the presence of prolonged and vigorous agitation the cream will churn before it can be transferred to the churn.

Further study is needed to justify a conclusive explanation of the underlying causes of these results. In the meantime, these findings suggest that the dominating forces that cause normal cream to represent an emulsion of fat in hydrated colloids (skimmilk) are disturbed. These forces are surface tension and adsorption. The equilibrium of the fat globules seems to be weakened, their surface tension diminished and the adsorbed material of concentrated skimmilk on the surface layer of the fat globules physically altered. As the size of the fat globules increases, their surfaces greatly decrease in proportion to their cubic contents, until finally a point is reached where the surfaces of the fat globules are no longer sufficient to hold the emulsion. The emulsion approaches the breaking point, hence the much increased tendency of the cooled cream to churn prematurely.

This oiling-off of the heated cream and its invariable production of mealy butter can be avoided readily by not allowing the treated cream to assume a state of rest until after cooling below the congealing point of the butterfat, which is 70°F. or below, and by cooling to or below this temperature rapidly. The premature churning is guarded against with a certainty by flash-cooling with but little or no mechanical agitation, as is readily accomplished by the use of coolers of the internal tube type.

SUMMARY

1. The key-note to permanent improvement of the quality of American butter lies in better cream. Those sections in this

country and those foreign countries that have established a reputation for butter of superior quality are invariably also the sections and countries that foster the production of good cream on the farm. Butter is no better than the cream from which it is made.

2. In sections where the herds are small and limited to but a few cows, economic conditions seriously handicap the establishment of conditions essential to the production of cream of high quality. This renders progress in cream improvement slow. Cream from such sections often contain diverse off-flavors. Among these flavor defects seasonal feed and weed flavors, flavors absorbed from foreign substances, and fermentation flavors of varying degrees of intensity are of common occurrence.

3. Many of these off-flavors are volatile or volatilizable. It is possible, by intensive treatment of this cream, to remove the volatile and volatilizable flavors and odors and to thereby improve the quality of the cream and raise the score and market value of the resulting butter.

4. The treatment that has been found most effective in removing off-flavors from cream for buttermaking consists briefly of standardizing the cream to a reasonably low, definite point of acidity, flash pasteurizing it and spraying it into a high vacuum, then blowing heated air through a continuous spray of the hot cream while still maintaining a partial vacuum until the cream is free from all removable off-flavors, as determined by drawing samples from the vacuum apparatus.

5. The time necessary for this treatment varies with type and intensity of flavor defect, it ranges from instantaneous treatment, in which the cream passes from the pasteurizer through the vacuum and cooler into the holding tank in one continuous operation, to intermittent or batch treatment in which the cream is held and treated under vacuum for from fifteen to thirty minutes and even longer in extreme cases.

6. In order to avoid all danger of premature churning and insure butter with a smooth texture free from mealiness, it is necessary to keep the cream in motion until cooled and to cool it rapidly and without excessive agitation.

7. While the application of this method of removing flavors from cream for buttermaking has been reduced to commercially successful and practical operation, some of the technical phenomena encountered in this work require further study for satisfactory explanation of the scientific principles involved. The most important of these are: The ratio of evaporation, the behavior of individual flavors, conditions controlling their volatilization, and the physical changes of the fat units. These problems are now under investigation and their solution promises the revelation of additional interesting and valuable scientific facts.

REFERENCES

(1) AYRES AND JOHNSON: Removing of onion flavor from milk and cream. U. S. Dept. Agri., Farmers Bulletin 608, 1914.

(2) RAHN AND MOHR: Fettverteilung in pasteuriziertem Rahm. Zeitschr. Milchw. Forsch. Band. I, Heft 5 and 6, 1924.

RELATION OF WATER TO MILK BORNE TYPHOID*

CARL R. FELLERS[1]

University of Washington, Seattle, Washington

AND

ROY S. DEARSTYNE

North Carolina Agricultural and Mechanical College, Raleigh, North Carolina

I. LONGEVITY OF BACT. TYPHI AND ALLIED SPECIES OF BACTERIA ON DAIRY UTENSILS AND IN WATER

In the course of extensive field and laboratory work on dairy and milk inspection problems in the South, the authors became thoroughly convinced of the tremendous importance of a safe water supply on dairy farms. This is not by any means an original or new idea for it has been pointed out before by a number of able sanitarians and scientists. For example Health Officer Letter No. 13 of the Bureau of Animal Industry, United States Department of Agriculture, issued in 1918 deals entirely with this subject. Nevertheless there is a well recognized dearth of actual data based upon experimental work upon which the sanitarian or milk inspector may draw. This paper is presented therefore for the purpose of furnishing some definite information upon the following points: First, the longevity of certain bacteria of the typhoid group upon dairy utensils and in water; second, the extent of pollution of certain dairy farm water supplies and third, the efficiency of various methods of washing and sterilizing dairy utensils, particularly bottles.

A very brief résumé of the more important investigations on this subject is presented as a useful adjunct to the experimental data which follows.

* Received for publication June 20, 1924.

[1] Joint contribution from the Department of Food Preservation, University of Washington, Seattle, and Pathological Laboratory, North Carolina Agricultural and Mechanical College, Raleigh, North Carolina.

As a result of investigating 638 epidemics of typhoid fever Schuder (8) concludes milk caused the disease 111 times or 17 per cent. Trask (27) investigated 179 typhoid outbreaks due chiefly to milk and found 113 of these were traceable to farms, dairies or milk shops. Four outbreaks were traced to infected milk bottles, two to infected milk utensils and others to a variety of causes.

Germano (4) concludes drying destroys typhoid bacilli but where there is a trace of moisture as in clothing, dirt or fecal filth, they may retain their vitality for a long time. A few resistant individuals resisted drying a very long time though most of the organisms were destroyed in a short time. Neisser (16) does not believe it possible to spread typhoid by dust though Flugge (5) claims bacilli may remain alive for 15 days. Robertson (22) found that typhoid bacilli may live in soil for at least several months whereas Martin (15) showed their longevity in soil varied according to the character of the soil flora. Viable cells of *Bact. typhi* were recovered from dried soil after 456 days. In fresh milk it is known that the typhoid bacillus may find a very favorable medium for growth. In this connection Washburn (28) found it to survive several months in fresh sweet milk. Northrup (17) demonstrated milk must become 80 degrees acid before *Bact. typhi* is destroyed thus partly substantiating Krumweide and Noble (14) who report it is killed in sour cream and acids and that the rate of destruction depends on both the acidity and the number of bacteria present. Bassenge (18) also states a 0.3 to 0.4 per cent acidity in milk will destroy typhoid bacilli after 24 hours. On the other hand Potter (25) asserts that lactic acid bacteria exert no repressing effect on *Bact. typhi* and will not render harmless a contaminated milk supply. Herzog (7) states this organism generally finds its way into milk through contaminated water used to wash the dairy utensils. He finds milk exerts first a depressing effect on the organisms followed by a marked increase in numbers.

Jordan, Russel and Zeit (12) reported that *Bact. typhi* died in 7 days in lake water and in about 3 days in polluted water. Later Russel and Fuller (26) working under somewhat dif-

ferent conditions, confirmed these results in a general way. Houston (9) determined that it required 9 weeks for the total disappearance of *Bact. typhi* from river water, though 99 per cent of the organisms died in one week. He further concluded that the rate of death of this organism in pure natural water follows the velocity law for monomolecular reactions. Phelps (20), also Cohen (2) have further verified this work. The latter investigator points out the importance of temperature and hydrogen ion concentration in this connection. The optimum pH value for *Bact. typhi* was shown to be from 5.0 to 6.4. Whipple (29) in reviewing longevity experiments states the results are contradictory, but considers few living cells will survive 25 days exposure in water. Salt, lake and well water are all declared to be unfavorable. Jordan (11) and also Gay (3) hold substantially the same views regarding the longevity of this organism. Park and Williams (19), Harrison (6), and Harrington and Richardson (5) are in accord in stating that the majority of cells of *Bact. typhi* are destroyed in 7 or 8 days in pure water, in a shorter time in very cold or in polluted waters, and that only a few resistant individuals survive after the first few days.

Sedgwick and Winslow (23) found freezing is very destructive to typhoid bacilli, over 90 per cent being destroyed in 2 weeks. A very few organisms were recovered after 12 weeks in ice. Prudden (21) demonstrated living cells in ice 103 days after infection. He states they may remain viable for several weeks in soil and in pure water. Bolten (1) determined the presence of living *Bact. typhi* in ice cream after a storage period of 45 days. According to Ishii (10) this organism dies out in glucose or mannite peptone media in from 3 to 8 days while in lactose or saccharose broth it survived for over a month. Young and Sherwood (30) also Koser and Skinner (13) investigated the effect of carbonated beverages on bacteria and agree in finding the numbers of *Bact. typhi* greatly reduced after a few hours contact, yet some few cells remained viable for several days.

EXPERIMENTAL

Preliminary experiment 1. One loopful of a diluted twenty-four culture of *Bact. typhi* Hopkins strain (Hygienic Laboratory), was placed in each of a series of dry sterile petri dishes. Direct microscopic examination showed about 20,000 bacteria per loop. The loopfuls of saline dried in about 10 minutes. The storage chamber was dark and was maintained at a temperature of from 20° to 23°C. Plates were removed at the end of the following periods of time: 1, 2, 4, 6, 8, 12, 16, 24, 36 and 48 hours. Two plates were tested at each period by the addition of plain peptone, beef extract agar pH value 7.0, to one plate and Endo agar to the other. Plates were then incubated at 37°C. for as long as necessary to determine whether growth was present. Accurate numerical estimation of the colonies was not possible and for this reason the growth was classed as +, ++, +++, ++++ according as the growth was scant or vigorous. It was necessary to examine the plates several times as the appearance of the characteristic colonies of *Bact. typhi* was occasionally delayed for 4 or more days. The results of this preliminary experiment are incorporated in table 1. The most rapid diminution in numbers occurred from the second to the fourth hour. At the 48 hour testing period approximately 75 per cent of the organisms had been destroyed. No tests were made after 48 hours because all the test plates had been used.

Experiment 2. This is a repetition of experiment 1 with the exception that the drying period was much extended and several other species of bacteria were used. The detail of the experiment was identical in every way except duplicate plates of both plain and Endo agar were used at each test period. This was done to avoid discrepancies observed in the former experiment. The data are contained in table 1, only a brief discussion of the results being necessary.

Bact. typhi Hopkins strain, survived (2 out of 4 plates) 96 hours but not 120 hours. *Bact. typhi* United States Army strain survived 168 but not 192 hours. An average of only

TABLE 1

Longevity of typhoid group when dried on glass plates or rods

TIME ELAPSED	EXPERIMENT 1	EXPERIMENT 3	EXPERIMENT 2						
	Bact. typhi on glass plates	*Bact. typhi* on glass rods	*Bact. typhi* Hopkins	*Bact. typhi* Army	*Bact. paratyphosum A*	*Bact. paratyphosum B*	*Bact. dysenteriae* Shiga	*Bact. dysenteriae* Flexner	*Bact. enteritidis*
hours									
1	++++*	+++	++++	++++	++++	++++	++++	++++	++++
2	++++	+++	++++	++++	+++	++++	++++	++++	++++
4	+++	+++	++++	++++	+++	++++	++++	++++	++++
6	+++	+++	++++	++++	++	+++	++	++	++++
8	++	+++	++++	+++	+	++	++	++	++++
12	+	+++	+++	+++	−	++	++	−	++++
16	+	No test	No test	No test	No test	No test	No test	No test	No test
18	No test	+++	+++	+++	−	−	+(sl.)	−	+++
24	+	++	++	+++	−	−	−	−	+++
36	+	++	+++	++	−	−	−	−	+++
48	+	+	+	++	−	−	−	−	++
72	No test	−	+	++	−	−	−	−	++
96	No test	−	+(sl.)	+	−	−	−	−	+
120	No test	−	−	+	−	−	−	−	+
144	No test	−	−	−	−	−	−	No test	+
168	No test	+	−	+(v. sl.)	−	−	No test	No test	+
190	No test	−	−	−	−	−	No test	No test	−
214	No test	−	−	−	−	−	No test	No test	−
260	No test	−	−	−	−	−	No test	No test	−

*+ represents scanty growth or very few colonies.

++++ represents vigorous growth or a large number of colonies.

2 colonies per plate was obtained at the 168 hour testing period thus showing that all except a few resistant individuals had been destroyed long before this test period. *Bact. paratyphosum* A survived 8 but not 12 hours, most of the organisms being killed within 2 hours after being placed on the glass dishes. *Bact. paratyphosum* B withstood desiccation 12 but not 24 hours. The plates poured at the 18 hour period using the latter organism showed only 2 colonies on the 4 plates. It is evident that the life of the dysentery group of bacteria is limited to a few hours at most when dried under these conditions, because *Bact. shigae* survived 8 but not 12 hours and *Bact. dysenteriae* Flexner survived the 12 but not the 24 hour period. Most of the living cells of both of these species were destroyed during the first 4 hours of exposure. In the case of the latter only a total of 2 colonies were discovered on a total of 4 plates under examination at the 18 hour testing period. On the other hand *Bact. enteritidis* survived 168 hours of desiccation though the number of surviving organisms after the 96 hour test period was very small. No colonies were found after 192 hours in storage.

Experiment 3. In this experiment the bacteria were dried on sterile glass rods. A 24 hour culture, diluted with about 10 times its volume of water, was used as the inoculant. A direct microscopic count showed there were less than 100,000 organisms per rod. The rods were dipped to a depth of about ½ inch in the diluted culture, drained 30 seconds, touched to the side of the tube and transferred at once under aseptic conditions to large cotton-stoppered test tubes for storage. Upon examination it was found that the culture appeared perfectly dry in 4 hours. In order to make the test for the presence of living bacteria the glass rods were transferred to tubes of plain broth and incubated. All tests were made in triplicate, that is 3 glass tubes were used at each test period. The results are found tabulated in table 1. *Bact. typhi* Hopkins was the organism used.

It was found that all cultures made up to 24 hours were strongly positive. After this length of time had elapsed however, nearly all the organisms had been destroyed. For example

one tube appeared sterile after 24 hours, two tubes after 36 hours and 2 tubes after 48 hours. In the latter case, the growth did not appear until after 5 days incubation, due no doubt to the impairment of the vitality of the organism. After the 48 hour test period no more positive cultures were obtained from the rods until the 168 hour test. From one of the tubes atypical culture of *Bact. typhi* was obtained. From these and other results obtained throughout this work it appears that occasionally very resistant individual cells are encountered. In every case these resistant types were true to the species type and although their pathogenicity was not tested, it seems probable that it remained unimpaired. A very great majority of the cells are readily destroyed after a very few hours drying.

Experiment 4. It was determined to test out the effect of a milk film upon the longevity of some of the typhoid group. For this purpose the loop method already described was used. First a drop of sterile milk was placed in a sterile petri dish and spread out well with the aid of a platinum wire. Then a loop of a diluted 24 hour culture of the organism being tested was spread about in the milk film in the glass dish. Check plates made at the same time and under identical conditions but containing no milk film were used. All results are reported in table 2. Tests were made in triplicate, that is 3 plates were used as checks and contained no milk, while 3 contained both culture and milk.

Upon consulting table 2 it is seen that *Bact. typhi* survived 115 hours when dried alone without milk on the petri dishes. One of the 3 plates showed a few colonies after the 140 hour test period but all other plates examined after 115 hours storage were negative. When dried in contact with the milk film, large numbers of colonies of this organism were present on every plate even after the final test, i.e., 250 hours. Just why this dried milk film should protect bacteria for such a long time is not entirely clear. It is probable that the moisture and protective colloids which are present are important factors. Similar results were obtained with *Bact. paratyphosum* A when dried with a milk film. In this case many colonies were found

on the plates after the 192 hour test and a few (30 colonies) on the 3 plates tested at the 216 hour period. Where no film of milk was present the bacteria were all killed in 24 hours and only a few resisted 18 hours storage. *Bact. dysenteriae* without the milk film did not resist the 43 hour period, in fact

TABLE 2

Effect of milk films on the longevity of typhoid group when dried on glass plates

Experiment 4

TIME ELAPSED	BACT. TYPHI ALONE	BACT. TYPHI AND MILK FILM	BACT. PARATYPHOSUM A ALONE	BACT. PARATYPHOSUM A AND MILK FILM	BACT. DYSENTERIAE FLEXNER ALONE	BACT. DYSENTERIAE FLEXNER AND MILK FILM
hours						
1	+++	+++	+++	+++	+++	+++
2	+++	+++	+++	+++	+++	+++
4	+++	+++	+++	+++	++	+++
6	+++	+++	+++	+++	++	+++
8	+++	+++	+	+++	++	+++
12	+++	+++	+	+++	++	+++
18	+++	+++	+	+++	++	+++
24	+++	+++	−	+++	+	+++
36	++	+++	−	+++	−	+++
43	++	+++	−	+++	−	++
67	+	+++	−	++	+	++
96	+	+++	−	++	−	++
115	+	+++	−	++	−	+
140	+(sl.)	+++	−	++	−	+
168	−	+++	−	+++	−	−
192	−	+++	−	++	−	−
216	−	+++	−	+	−	−
250	−	+++	−	−	−	−

nearly all the cells were destroyed after 6 hours. One doubtful plate showed 3 colonies of after the 67 hour test but all other tests made after the 43 hour period were negative. Where milk was present the organisms survived 140 hours desiccation but not 168 hours. Large numbers of colonies were found on the plates made at the 115 and 140 hour periods.

Discussion of the desiccation experiments

These experiments indicate that *Bact. typhi* and to a lesser degree *Bact. paratyphosum* A and *Bact. dysenteriae*, in spite of the fact that they are non-spore formers, are able to withstand considerable desiccation before being destroyed. In thin films on glass plates or rods *Bact. typhi* (2 strains) showed survival after 92 hours and in one case even after 168 hours. Where a thin film of milk was present in addition to the bacterial film, the organisms from 7 to more than 10 days. Similar results were obtained with the dysentery and paratyphoid cultures, though neither appears to be as resistant as the typhoid bacillus. In the case of the 2 strains of the latter organism tested, they were still viable after from 5 to 7 days when dried on glass with a thin film of milk.

These data show clearly the necessity of using pure water to wash milk bottles and other utensils, for if any of the intestinal bacteria were present they could easily survive long enough to infect the milk. Often the length of time elapsing between the time of washing utensils at the dairy and the time of the next milking is only a few hours. In spite of laws to the contrary in many cities and towns, the rinsing of dairy utensils after the usual superficial disinfection, is sometimes done. Not only is this washing and rinsing often done with polluted water but the entire cleansing process often consists of a superficial washing of the bottles and utensils in luke-warm water with a little soap or cleaning preparation. The removal of all traces of curdy and slimy particles from milk bottles and utensils is also of the greatest importance because bacteria of the typhoid-dysentery type are able to survive in thin films of milk for a week or 10 days without apparent loss of vitality. It is also well known that steam or a disinfecting solution do not readily penetrate beneath such curd or slime areas. It is believed that thorough cleansing of all utensils, in addition to the use of a good steam cabinet or an efficient liquid disinfectant, is essential in protecting the public from the dangers of typhoid infection from polluted water or carriers. Of course wherever pasteurization is ef-

fectively done, this serves as an additional safeguard against the spread of infection from milk.

Steam sterilization for the disinfection of bottles and other utensils is used to good advantage in most of the large well equipped milk plants but the small dairyman must have recourse to either an easily prepared disinfectant which must be both harmless yet efficient, or else a simple steam sterilization outfit. Several such disinfectants including chlorinated lime and similar substances have been suggested. Some data obtained regarding the efficiency of various methods of cleaning and sterilizing milk utensils, particularly bottles will be included in part III of this paper.

Longevity of typhoid group of bacteria in surface, mineral and sea water

For these experiments large, hard, white glass reagent bottles containing 7 liters were used. The organisms tested were *Bact. typhi* Hopkins strain, *Bact. paratyphosum* A and *Bact. shigae*. The bottles containing 5 liters of water each were sterilized by heating in flowing steam for one hour, inoculated when cool with a 24 hour culture (1:10) of the organism to be tested and stored in a very subdued light at a mean temperature of 60.9°C. Samples for examination were removed by means of sterile pipettes. The tap water used was unchlorinated Seattle tap water from Cedar River, the salt water from Puget Sound near Seattle while the mineral water was artificially prepared in the laboratory to closely simulate White Rock Lithia Water. Three media were used in making the tests. These were plain broth, plain agar (A. P. H. A.) and Endo agar. The purpose of the peptone broth was to serve as a check on the solid media. At each testing period colonies were fished from the plates and occasionally cultured to make certain of their identity. No contaminations occurred until after the 3 months testing period when white and yellow micrococci were found in 2 of the bottles. One of these was inoculated with *Bact. paratyphosum* A and the other with *Bact. shigae*, both in mineral water. The results in full are incorporated in table 3.

TABLE 3

Longevity of typhoid group in surface, salt and mineral waters

TIME OF STORAGE	BACT. TYPHI HOPKINS ORGANISMS PER CUBIC CENTIMETER			BACT. PARATYPHOSUM A ORGANISMS PER CUBIC CENTIMETER			BACT. DYSENTERIAE SHIGA ORGANISMS PER CUBIC CENTIMETER		
	Tap	Sea	Mineral	Tap	Sea	Mineral	Tap	Sea	Mineral
2 hours	1,300	1,920	1,140	1,100	1,160	1,130	1,700	2,530	3,600
22 hours	1,530	6,100	7,200	820	3,180	5,640	1,080	2,100	8,000
46 hours	580	25,000	35,000	1,730	20,000	50,000	800	2,280	50,000
72 hours	300	50,000	80,000	1,400	20,000	50,000	450	50,000	1,050
96 hours	240	80,000	100,000	1,140	50,000	80,000	200	80,000	900
144 hours	40	100,000	100,000	830	170,000	170,000	30	170	100,000
7 days	10	350,000	700,000	100	1,800,000	1,600,000	16	100	600,000
9 days	6	300,000	800,000	100	1,600,000	800,000	1	20	800,000
11 days	6	No test	No test	150	No test	No test	0	30	No test
13 days	8	150,000	300,000	10	720,000	265,000	2	6	480,000
15 days	3	120,000	150,000	0	600,000	200,000	0	0	1,000,000
21 days	0	70,000	80,000	0	240,000	120,000	0	0	100,000
30 days	0	30,000	25,000	0	10,000	400,000	0	0	60,000
3 months	0	5,000	20,000	0	20,000	80,000	0	0	20,000
6 months	0	200	Positive	0	600	Positive	0	0	Positive

Discussion

Considering first of all the action of tap or surface water upon these organisms, it was found that all 3 species tested were destroyed between the thirteenth and twenty-first days. *Bact. typhi* survived longest followed closely by *Bact. paratyphosum* A and *Bact. shigae*. The death rate follows closely the logarithmic curve of the velocity law as related to a monomolecular reaction. A few resistant individual cells linger for many days before finally succumbing, though a great majority are destroyed in the first 7 days.

In salt water the death rate was much different from that found in surface water, and was different for each species tested. Considerable multiplication took place in all species used though *Bact. shigae* did not multiply to the same extent nor live as long as the other bacteria. Some living cells of both *Bact. paratyphosum* A and *Bact. typhi* were recovered from the samples after 6 months storage. All 3 species showed a gradual decrease followed by a similar gradual increase in numbers in salt water. Although this water was not analyzed it is possible that traces of organic matter sufficient for the needs of these organisms was present. It is apparent from this experiment at least that sea water like normal saline forms a more favorable medium to resist destruction than relatively pure surface water.

The results obtained with these 3 organisms in mineral water are in general similar to those just described where salt water was used. However the organisms multiplied to a much greater extent in the mineral water and all were still in a viable condition at the end of 6 months when the experiment was concluded. No organic matter was intentionally added; the large increase in the numbers of organisms cannot therefore be ascribed to the presence of more than a trace of organic matter. One-tenth cubic centimeter of a 1:10 peptone broth was added to the water as the inoculant. The amount of organic matter transferred in this matter was very small indeed. At any rate the data substantiate results obtained by other investigators respecting the longevity of these bacteria in certain kinds of

water. One reason why results in the literature are so discordant is undoubtedly because of the great difference in the character of the water samples employed as well as other experimental conditions which are difficult to duplicate in different laboratories.

Effect of direct sunlight on the viability of the typhoid group in water

This experiment was an exact duplicate of the former one except that tap water only was used, and the bottles were stored in a window exposed to the direct rays of a June sun during the greater part of the day. The results are given in table 4.

Table 4 shows that the 2 strains of *Bact. typhi* and the one strain of *Bact. typhosum* A tested in this experiment had com-

TABLE 4

Effect of sunlight upon the viability of typhoid group in surface (tap) water

DURATION OF STORAGE	BACT. TYPHI HOPKINS ORGANISMS PER CUBIC CENTIMETER	BACT. PARATYPHOSUM A ORGANISMS PER CUBIC CENTIMETER	BACT. TYPHI ARMY ORGANISMS PER CUBIC CENTIMETER
hours			
1	15,000	10,000	12,000
24	9,500	100	12,000
96	0 (1 cc.)	0 (1 cc.)	0 (1 cc.)
120	0 (2 cc.)	0 (2 cc.)	0 (2 cc.)

pletely died out in 4 days, probably before, but due to unforseen circumstances tests could not be made at the end of 48 and 72 hours as originally planned. Again *Bact. typhi* appears to be more resistant than *Bact. paratyphosum* A, for only 1 per cent of the latter survived even 24 hours while the former did not greatly diminish in numbers until after the first 24 hours. The action of direct sunlight upon these bacteria in tap water is probably one of the principal causes for the speedy destruction of the living cells, at least other conditions were made identical to the previous experiment where the organisms survived for a much longer time when not exposed to direct sunlight.

The practical application of these longevity experiments in water is obvious. The relation of them to farm and public water supplies will not be discussed here because it is our motive

to point out the danger of an unsafe water supply on dairy farms to the milk consuming public. The water may be used to wash or rinse utensils and bottles and thus transfer the harmful organisms directly to the milk. Then of course is the danger of carriers who have contracted the disease by consuming the infected water. It has been demonstrated by the desiccation experiments that typhoid and allied bacteria may live many hours on glass utensils, and even a week or more when a thin film of milk protects them. It has also been shown that these organisms are able to retain their vitality in surface, mineral and salt water for at least several days thereby increasing the chances of infecting the milk supply. It will be seen therefore that the danger of a polluted farm dairy water supply is indeed a real one. Data bearing on the pollution of these wells is presented in Part II of this paper.

Summary

Bact. typhi, *Bact. enteritidis* and to a lesser extent *Bact. paratyphosum* A and the dysentery bacteria are able to withstand desiccation upon glass for periods of time varying from 8 hours to several days. In general *Bact. typhi* was the most resistant as in 2 cases it resisted 96 hours and in one case even 168 hours. The longevity of this group of bacteria varied considerably in the different tests.

Where a thin film of milk was present with the dried culture, the above organisms survived for from 7 to 10 days, thus greatly increasing the time necessary to destroy them. The film of milk acts as a protective coating and through the retention of moisture or other reasons effectively preserves the vitality of the bacteria for several days.

The rate of destruction in every case was greatest during the first few hours of drying. A few resistant individual cells still survived long after the great majority of the organisms had been destroyed.

Bact. typhi, *Bact. paratyphosum* A, and *Bact. shigae* when placed in a pure surface water survived from 13 to 20 days.

The death rate followed closely the logarithmic velocity curve of a monomolecular reaction. In salt and in mineral waters these organism decreased for a time then greatly increased in numbers so that, except for *Bact. shigae* in salt water, all survived in small numbers even after 6 months storage in the dark. It is believed that a sufficient amount of organic matter for limited bacterial growth was present in these water samples in order to account for such a long survival.

Using surface water alone stored in the direct sunlight, it was found that *Bact. typhi* and *Bact. paratyphosum* A were destroyed in less than 4 days.

The data indicate that bacteria of the typhoid group are able to survive in water and on glass surfaces for a sufficient length of time to infect milk on the average farm. All milk utensils should be washed with great care as it was demonstrated that a thin milk film or curd particles protect bacteria from destruction by desiccation. There is a real danger in using polluted water for the purpose of washing or rinsing dairy utensils. Since many wells and springs on dairy farms are polluted, an efficient but non-poisonous disinfectant such as chloride of lime or hypochlorite should be used to sterilize utensils where steam is not available.

II. EXTENT OF WATER POLLUTION ON CERTAIN DAIRY FARMS

Sanitary surveys supplemented by bacteriological examinations of dairy farm wells and other water supplies were conducted by the writers in Mecklenburg, Cabarrus and Gaston Counties, North Carolina. In carrying out this survey all pertinent epidemiological data such as typhoid history, type of well or privy, dairy score, etc., were carefully collected. A series of 50 dairy farm wells and springs were taken at random in this typical southern area and samples were carefully collected and examined. Each well was examined at least twice if it showed a positive colon test the first time. In case the first and second examinations did not check, a third examination was always made. The total count of bacteria on Standard Agar (American Public Health Association) at 37°C. for 48 hours as well as

the presumptive and completed tests for the *Bact. coli* group, and differentiation of the latter into the fecal and non-fecal types, were made on every sample.

Table 5 gives a highly condensed summary of some of the epidemiological and bacteriological data collected regarding these dairy farm water supplies. In a large measure these data are self explanatory. For example it is evident at a glance that the open bucket and poorly protected types of wells showed the highest degree of contamination with the colon group. According to the present standards of the American Public Health Association (32), and water sample showing the presence of

TABLE 5

Bacteriologic and epidemiologic data on 50 representative farm dairy water supplies

TYPE OF SUPPLY	NUMBER	AVERAGE DEPTH	NUMBER PROTECTED FROM SURFACE DRAINAGE	AVERAGE DISTANCE NEAREST BUILDING	TOTAL COUNT BACTERIA PER CUBIC CENTIMETER	POSITIVE PRESUMPTIVE TEST FOR BACT. COLI GROUP	POSITIVE COMPLETED TEST FOR BACT. COLI GROUP	NUMBER SHOWING PRESENCE OF FECAL TYPE OF BACT. COLI GROUP
		feet						
Open bucket wells	21	31.5	11	30.5	130	19	19	12
Dug wells with pump	17	36.8	12	38.0	61	14	13	6
Flowing springs	6	Shallow	3	275	33	6	6	3
Drilled wells with pump	6	75.5	6	23	5	0	0	0

the *Bact. coli* group of the fecal or even the non-fecal types is classed as at least potentially dangerous. The 6 deep, drilled wells with pumps furnished water of exceptional sanitary quality —an excellent argument for the drilled well. A total of 38 wells or springs or 76 per cent showed the presence of the *Bact. coli* group of the fecal or non-fecal types; however, on differentiating these it was found that only 21 or 42 per cent actually contained fecal types. Fifteen samples contained both fecal and non-fecal types, while 7 contained the fecal type alone. Thus we see that the non-fecal members of the colon group are more than twice as numerous in these farm wells as are the

fecal types. This is an important point and one which the authors feel has not been sufficiently dwelt upon in the past. It is a well known fact that no differentiations are made as to type in routine water examinations in most laboratories. Our results tend to corroborate Chen and Rettger (31) who found only 20 or 4.3 per cent of 467 cultures or colon-like soil organisms were actually fecal *Bact. coli*. Of the remaining 447 cultures, 430 were *Bact. aerogenes* and 17 were *Bact. cloacae*.

As stated before in this paper, there is a greater chance for dairy farm wells to become polluted with fecal colon bacteria than similar wells not located on dairy farms. This is because of the greater opportunity of cow dung getting into the water supply where cattle are kept. For example the authors in collaboration with Mr. L. R. Jones, bacteriologist, United States Public Health Service, examined one hunderd wells in the 5 mile extra-cantonment zone at Camp Greene, Charlotte, N. C., in 1918 and found 40 per cent were polluted by the undifferentiated colon test. Each well was examined at least twice. Since probably one-half of the wells classed as polluted contained non-fecal colon-like organisms only, it is evident that only about 20 per cent of the wells actually contained fecal *Bact. coli*. This percentage is only one-half that found in dairy farm water supplies from this same district.

In the first series of 50 wells, eight families gave positive typhoid histories, while one active case was found. Since active or carrier cases of this disease may readily infect bucket type or poorly protected wells or springs, and because milk utensils may be washed or rinsed in this same water, the danger from typhoid on these farms is indeed very real. Such danger is not present to the same extent in communities where pasteurization is practised, nevertheless we should go to the source of the trouble first of all. The water supply should be carefully safeguarded from pollution, in addition to this all utensils should be thoroughly washed and sterilized either by steam or some suitable disinfectant, and lastly as a final safeguard, the milk should be efficiently pasteurized.

Summary

In a series of 50 dairy farm wells and springs tested bacteriologically, 38 or 76 per cent contained members of the *Bact. coli* group. In this series only 21 or 42 per cent actually contained fecal types of this group as differentiated by the methods of the American Public Health Association. Of 100 wells and springs in the same district but not from dairy farms 40 were found to be polluted by the undifferentiated colon test.

Dairy farm water supplies are more likely to be polluted with fecal bacteria than similar supplies on other farms because of the presence of cow dung.

According to some of the present methods of interpreting the results of a sanitary water examination, many samples are classed as polluted which really contain no fecal organisms.

III. EFFICIENCY OF VARIOUS METHODS OF WASHING AND STERILIZING DAIRY UTENSILS

In cities and towns where the milk supply is marketed raw, the milk and dairy inspection department of these municipalities must always be on the alert for milk-borne epidemics. Few, if any epidemics of contagious disease have been traced to milk which has been properly pasteurized, because the heating and holding process of pasteurization (142° to 148°F. for 20 to 30 minutes) destroys non-sporeforming disease-producing organisms which might have found their way into the milk. Aside from this, the facilities for bottle and can sterilization in modern pasteurizing plants are usually such as to preclude chances of contamination of milk subsequent to the pasteurizing operation.

The means of entrance of disease producing organisms into the milk supply are many, but the object of this paper is primarily to correlate polluted water supplies with some of the milk borne diseases.

Nissen (36) found *Bact. typhi* cultures are killed in 10 minutes in a dilution of 0.06 per cent of chlorinated lime and in 5 minutes in a 0.12 per cent solution of this substance. This work was substantiated by Taylor (37) who asserts a chlorinated lime

solution of such strength that there is one part available chlorine to 5000 parts of water, is very effective and completely sterilizes dairy utensils in a one minute exposure, providing the bottles and milk cans have been throughly scrubbed to remove particles of curd. Van Saun, Bancroft and O'Gorman (38), and also Berry (33) made a study of the glass and dish washing problem in restaurants, soda fountains and other public places. They conclude that strong chloride of lime solutions effect practically instantaneous sterilization, but that the disinfectant should be rinsed from the utensil. These investigators as well as Cole (34) and Manheimer and Ybanez (35) proved that unless a chemical disinfectant is used, boiling water is necessary to effect sterilization. Theoretically bottles and utensils should be efficiently sterilized and properly stored. If the sterilization has been adequate and the storage conditions suitable, the chances of infection from such sources as worked out in parts I and II of this paper are negligible, but, in cities in which milk regulation work is in its infancy, and which derive all or a part of their supply from small dairies marketing a raw product, the usual tendency of the dairyman is to adhere to the old time principles of sanitation and cleanliness. Most of these small dairies operate on a very narrow margin, being for the most part conducted in conjunction with diversified farming. There is often a shortage of bottles, cans and other utensils. Cleaning and sterilizing is rushed through at the last moment, the bottles perhaps superficially washed in soap solution, and dipped in so-called boiling water which is not boiling at all, but merely luke warm, rinsed and drained. Then too on the part of some of the dairymen, there is the inevitable tendency to clean out the cans and pails superficially, and then to sterilize and rinse them hurriedly. Despite the most rigid of laws and efficient systems of inspections, this practice is more or less in vogue at small dairies that lack live steam cabinets having capacity for sterilizing and storage. Hence we have polluted water a potent factor in the spread of milk-borne diseases.

The writers collected so-called sterile bottles ready for filling, under conditions as listed from several raw milk dairies, capped

and carried them to the laboratory. Here 100 cc. of sterile water was placed in each, the bottle again capped and thoroughly

TABLE 6

Bacterial counts per bottle

Bacteria per bottle

WASHED IN HOT WATER AND RINSED WITH A COMMERCIAL HYPOCHLORITE DISINFECTANT*			WASHED IN HOT WATER		LIVE STEAM	
Quarts	Pints		Quarts	Pints	Quarts	Pints
3,600	300	100	900,000	60,000	Sterile	Sterile
500	200	Sterile			200	Sterile
300	200	200	50,000	800,000	400	Sterile
1,500	100	500	100,000	660,000	500	Sterile
200	100	Sterile	120,000	1,500	500	200
200	400	500	1,000,000	300,000	400	100
800	100	100	600,000	8,000	200	100
200	100	Sterile	1,000,000	60,000	400	300
100	500	500	800,000	500,000	400	Sterile
200	2,000	200	63,000	50,000	900	400
500	500	300	10,000	2,000	1,200	100
200			3,400	5,000	200	25,000
			1,500	63,000	100	300
				3,000	20,000	120
				1,000	400	Sterile
				20,000	800	200
				4,000	100	Sterile
				8,000		300
				800		
692 Average for 12 quarts	313 Average for 22 pints		387,000 Average for 12 quarts	41,400 Average for 18 pints	1,480 Average 18 quarts omitting 20,000 count. average is 395.	1,430 Average for 19 pints. 120 average for 18 pints omitting a 25,000 count.

*Containing about 0.02 per cent available Cl.

agitated, proper dilutions made, plated and counted according to the standard methods of milk analysis of the American Public Health Association. The results undoubtedly represent a

minimum count of the bacterial flora of the bottles, and while the count is practically inconsequential from the standpoint of grading milk on the numerical basis, it is highly dangerous owing to the questionable nature of the organisms which the bottle is adding to the milk. Table 6 contains the results of this experiment.

There is little question in the authors' minds that the bottle and utensil question is of paramount importance especially where the total milk supply, or part of it is marketed raw. In the smaller cities and towns where no pasteurization is carried on and little attempt is made to regulate the milk supply, the matter of polluted water on dairy farms is of paramount importance.

These data show that sodium hypochlorite was very useful even when used merely for rinsing, in keeping the numbers of bacteria per bottle to a minimum. Live steam was also efficient, but the curd must previously be well removed by washing else a high count will occasionally result. So called "hot water" washing is inefficient and unsatisfactory from a bacteriological standpoint.

The authors believe that the use of sodium hypochlorite is the equal or superior of steam in the sterilization of milk bottles and dairy utensils, and since it is relatively inexpensive and easy to use and entirely harmless, they strongly recommend its use.[2]

REFERENCES

(1) BOLTEN, J. 1918 U. S. Public Health Reports, xxxiii, 163.
(2) COHEN, B. 1922 Jour. Bact., iii, 253.
(3) GAY, F. P. 1918 Typhoid Fever. Text. The Macmillan Co., New York.
(4) GERMANO, E. Ztschr. Hyg., xxiv, 403; xxv, 439, xxvi, 66 and 273.
(5) Quoted by HARRINGTON, C., AND RICHARDSON, M. W. 1914 A manual of practical hygiene. Lea and Febriger, Philadelphia, p. 366.

[2] Since the writing of this manuscript an article by Whittaker and Archibald, Public Health Reports 39, 923 (1924), has appeared. The use of calcium hypochlorite in concentrations of not less than 35 parts per million is recommended for washing milk bottles. Washing in such a solution was found to be more efficient bacteriologically than any other means, including steam.

(6) HARRISON, F. C. 1921 Marshall, C. E. Microbiology. Third ed. P. Blakiston's Sons & Co., Philadelphia.
(7) HERZOG, M. 1910 Text. Disease Producing Microörganisms, p. 485.
(8) Quoted by HERZOG, M. 1910 Disease Producing Microörganisms, p. 485.
(9) HOUSTON, A. C. 1905 First report on research of Metropolitan Water Board, London.
(10) ISHII, O. 1920 Jour. Bact., v, 437.
(11) JORDAN, E. O., RUSSEL, H. L., AND ZEIT, F. R. 1904 Jour. Inf. Dis., i, 461.
(12) JORDAN, E. O. 1918 General Bacteriology. Sixth ed.
(13) KOSER, S. A., AND SKINNER, W. W. 1922 Jour. Bact., vii, 111.
(14) KRUMWEIDE, C., AND NOBLE, W. C. 1915 Collected studies of Bureau of Laboratories, N. Y. City, viii, 311.
(15) MARTIN, S. 1898, 1899, 1900, 1901 Ann. Rpts. Local Govt. Bd., London.
(16) NEISSER, M. 1901 British Med. Jour., September 14.
(17) NORTHRUP, Z. 1911 Mich. Agr. Exp. Sta. Tech. Bul. 9.
(18) Quoted by NORTHRUP, Z. 1911 Mich. Agr. Exp. Sta. Tech. Bul. 9.
(19) PARK, W. H., AND WILLIAMS, A. W. 1910 Pathogenic Microörganisms. Fourth ed. Lea and Febriger, Phila.
(20) PHELPS, E. B. 1911 Jour. Inf. Dis., viii, 27.
(21) PRUDDEN, T. M. 1891 Drinking Water and Ice Supplies, p. 92.
(22) ROBERTSON, J. 1898 British Med. Jour., January 8.
(23) SEDGWICK, W. T., AND WINSLOW, C-E. A. 1902 Mem. Amer. Acad. Arts and Sci., xii, 467.
(24) Standard Methods for the Examination of Water and Sewage. Fourth ed. 1920 Amer. Pub. Health Assoc., Boston.
(25) Quoted by TANNER, F. W. 1919 Bacteriology and Mycology of Foods. John Wiley & Sons, New York, p. 425.
(26) Quoted by TANNER, F. W. 1919 Bacteriology and Mycology of Foods, p. 343.
(27) TRASK, J. W. 1912 U. S. Hygienic Lab. Buls. 56 and 41.
(28) WASHBURN, H. J. 1908 25th Ann. Rpt. U. S. Bur. Animal Ind., p. 297.
(29) WHIPPLE, G. C. 1908 Typhoid Fever, Its Causation, Transmission and Prevention. John Wiley & Sons, New York, p. 47.
(30) YOUNG, C. C., AND SHERWOOD, N. P. 1911 Jour. Ind. and Eng. Chem., iii, 495.
(31) CHEN, C. C., AND RETTGER, L. F. 1920 Jour. Bact., v, 253.
(32) Standard Methods for the Examination of Water and Sewage. Fourth ed. 1920. American Public Health Association, Boston, Mass.
(33) BERRY, J. L. 1922 Quoted by VAN SAUN, A. I., BANCROFT, A. W., AND O'GORMAN, J. J. Amer. Jour. Pub. Health, xi, 669.
(34) COLE, H. N. 1916 Jour. Amer. Pub. Health Assoc., lxi, 1805.
(35) MANHEIMER, W. A., AND YBANEZ, T. 1917 Amer. Jour. Pub. Health, vii, 614.
(36) NISSEN 1890 Ztschr. Hyg., viii, 62.
(37) TAYLOR, G. B. 1919 Ann. Rpt. Intern. Assoc. Dairy and Milk Inspectors, viii, 205.
(38) VAN SAUN, A. I., BANCROFT, A. W., AND O'GORMAN, J. J. 1922 Amer. Jour. Pub. Health, xii, 669.

A COLOR TEST AND OTHER METHODS FOR QUALITY OF MILK[1]

TRANSLATED FROM THE FRENCH BY

B. H. NISSEN

Research Laboratory, Blue Valley Creamery Company, Chicago, Illinois.

For the rapid testing of milk for cheese making or other special purposes where unsuitable milk may be received, three rapid methods are at hand:

1. Determination of the refractive index of the calcium chloride serum of the milk.
2. Determination of the amount of catalase.
3. Alcoholic-alizarin test. The latter gives the most useful information.

Ackerman's calcium chloride serum method is best known. This is briefly as follows: 30 cc. of milk are introduced into a cylinder 230 mm. long by 20 mm. diameter, 0.25 cc. $CaCl_2$ solution is added and the whole shaken vigorously. Then place a refrigerant tube 260 mm. long by 10 mm. wide in the cylinder. A holder containing 12 to 24 such cylinders is placed in a bath of rapidly boiling water, for fifteen minutes; the water condensation collects on the refrigerant tube and is returned into serum. The refractive index is then made of the serum at 17.5°C. The calcium chloride solution used above contains 200 grams made up to a liter with water. Specific gravity 1.1375 at 15°C. Diluted to 1:10 this gives a refractive index of 26.0 ($n = 1.33743$).

The catalase number or amount is determined by aid of the apparatus of Koestler which is the simplest of the many described for the purpose. This is a cylinder of glass graduated at 10 and 15 cc., and provided with a one hole rubber stopper, carrying a tube connected with a eudiometer tube of 12 cc. capacity with

[1] The Rapid Analysis of Abnormal Milk by the Use of the Refractometer, by the Measurement of Catalase and by the Alcoholic-Alizarin Test. By Valencien and Panchaud. Le Lait, iii, 529 (1923).

0.1 cc. divisions. Ten cubic centimeters of milk and 5 cc. of oxygenated water containing 1 per cent H_2O_2 (about three volumes) are added, then whole shaken and stoppered. A combination of 12 such tubes is arranged in water at 25°, just covering the top of the eudiometer connection tubes. They are left immersed for about one minute to let the imprisoned air expand. The eudiometer tube filled with water is then inverted over the opening. After two hours time the amount of oxygen liberated by the catalase is read off on the eudiometer tube and reported on a basis of 100 cc. of milk.

The alcoholic-alizarin test of Morres consists in observing the color and modifications which 3 cc. of milk undergo when shaken with 3 cc. of neutral alcohol of 68 per cent strength saturated with alizarin (about 2 grams per liter) which acts as an indicator. For pure lactic acid fermentation of about 8° Soxhlet-Henkel (S.H.) or 18° Dornic (D.) (see table of colors for definition of these) the mixture of milk and alcohol-alizarin does not coagulate but takes a lilac-rose color. At 9° S.H. (20° D.) the liquid is sprinkled with fine flakes, while at 16° S.H. the liquid is very much coagulated and the serum separates. The color is lemon yellow. As one enters this limit of acid a very marked change in color is noted, the more so as the acidity is increased. The coagulation is also more marked and the flakes larger.

But under the influence of bacteria secreting the ferment "rennet," purely a chyme fermentation results, with no increase in acidity. It is observed, however, that the alcohol-alizarin milk mixture is much coagulated and even if the acidity is less than 8° S.H., the color is dark brick red. Milk from a diseased udder shows a violet color indicating alkalinity, since alizarin is yellow in acid and violet in alkaline solution. This is especially unfit for cheese. In warm weather or in the shipping of milk the test is applied by taking an equal quantity of milk and alcoholic-alizarin. All milk giving a yellow color is set aside to be used in cheese or butter making. In this way only good milk is put into refrigeration cans.

Tillman has determined the H-ion concentration of fresh milk to which lactic acid was added to give the alcohol-alizarin colors

1 to 10 by the chart of Morres. (The same colors are here obtained as with the natural fermentation.) The H-ion concentration expressed in pH for these colors is as follows:

1 = 6.53	5 = 5.17
2 = 6.49	6 = 4.57
3 = 6.10	7 = 4.06
4 = 5.83	8 = 3.70

By addition of sodium carbonate alkaline milk is formed giving the following pH:

9 = 6.61	10 = 6.83

By the aid of such colors one can therefore obtain an approximate H-ion concentration of any sample of milk.

The refractive index of the $CaCl_2$ serum of normal milk from a healthy cow varies from 38.5° to 40.5° Zeiss (n = 1.34218 to n = 1.34294). A very low index results either from "watering" or from trouble in the secretion of the mammary glands. Fresh normal milk has a catalase number varying from 3 to 15 and if the milk is secreted by diseased cattle the catalase value is much higher, from 20 to 130 according to the degree of secretion trouble. On the other hand, such diseased milk shows a violet color with alcoholic-alizarin. Thus the accumulation of the three characteristics, very low refractive index, elevated catalase number and violet color with alcoholic-alizarin is very good proof that the milk is from diseased cattle.

The catalase value generally runs parallel to the leucocyte index of Trommsdorf, a high catalase value corresponds to an abnormal functioning of the mammary gland. Presence of blood, however, raises the amount of catalse, even if present in traces. By the examination of the centrifuged precipitate blood can easily be distinguished from leucocytes. We have even examined a milk which had a high catalase value, often very low instead.

To illustrate the rapidity by which one may draw conclusions from these preliminaries, we will mention the case of a cheese maker in whose manufacture we had noticed considerable trouble in 1913. One morning at eight o'clock we took 40 samples of milk obtained from a territory about 15 kilometers from Geneva. It

was necessary that the cheese maker know by eleven o'clock what milk was to be suspected so it could be saved out from the rest. At the appointed hour this information was furnished him. The detailed condition of these samples of milk is given in tabular form showing the relation between the refractive index, the catalase value, and the alcohol-alizarin test.

(Four short tables were included in the original showing the relation between refractive index, catalase value, and alcohol-alizarin color for various samples of milk. A summary of these tables is given herewith.)

NUMBER OF SAMPLE	REFRACTIVE INDEX	CATALASE VALUE	ALCOHOLIC-ALIZARIN COLOR
V 14-1	38.6	8	Rose
V 14-2	37.0	43	Lilac rose
A 2-2	39.1	12	Rose lilac
A 2-4	39.1	10	Rose lilac
A 2-5	38.9	21	Rose lilac
A 2-7	39.3	50	Rose (coagulated)
A 2-10	38.5	22	Violet (abnormal)
V 1-1	39.0	13	Rose lilac
V 17-9	39.3	18	Rose lilac
V 14-2	37.8	20	Violet (abnormal)
A 2-9	39.0	25	Violet (abnormal)
A 9-1	40.1	12	Red brick (with deposit, abnormal)
B 20-1	38.3	21	Violet (slight deposit, abnormal)

These samples show that it is very easy to tell what milk is normal and what is abnormal.

From the above it would appear that the most reliable information is given by the alcoholic-alizarin method.

Translator's note: The rapid colorimetric method discussed in the above and given more in detail in the following should be of especial interest to dealers of milk and others desiring a simple method for acidity: Short, 2 cc. milk pipettes, 5-inch test tubes, and a small bottle of the alcohol-alizarin solution constitute the necessary materials. Seventy-two parts of 95 per cent alcohol, 28 parts of water, and 1 part of a 20 per cent alizarin paste (alizarin is sold in a paste of this strength), mixed and filtered after standing. This with a few drops of N/10 NaOH produces the red normal, alizarin color. It was found to

be fairly easy to distinguish milk differing by actual titration as little as 0.01 or 0.02 per cent so that if the alizarin indicator is of the right color (normal) to begin with, no difficulty should be experienced in obtaining results agreeing well with the usual titration method.

The following table gives the colors obtained with an alcohol-alizarin solution by which the nature of the change and the degree of acidity of milk can be approximated.

"S" indicates acidity in degrees Soxhlet, the number of cubic centimeters of N/4 NaOH required to neutralize the acidity of 100 cc. of milk.
"D" indicates acidity in degrees Dornic, the number of cubic centimeters of a NaOH solution containing 4.445 grams NaOH per liter required to neutralize the acidity of 100 cc. of milk.
1° Soxhlet or Soxhlet-Henkel = 2.25° Dornic (milk kept at 20°C.).

Degrees Dornic can be considered as acidity in hundreds per cent. Thus for a color of Rose (2°) the acidity would be approximately 0.18 per cent figured as lactic acid.

Preparation of the solution and method of using. Neutral alcohol is diluted with water to 68 per cent, 1.5 to 2 grams powdered alizarin, or the equivalent in paste form, is introduced into a liter of the above alcohol. This is allowed to stand and is filtered after six to twelve hours. If the filtrate is not of the desired color (aged bordeaux) it is adjusted to the right color (normal tint) by the addition of N/10 NaOH or N/10 acid.

To use, mix 2 or 3 cc. of milk with an equal quantity of the alizarin solution in a tall cylinder and observe the color and degree of coagulation. Compare with the scale of colors 1° to 10° given on the chart as follows:

NORMAL COLOR (WINE RED)	COLOR OF ALCOHOL-ALIZARIN
1° Red lilac	7° S. = 16° D. (approx.)
Fresh normal milk. No precipitation. No coagulation after 7 hours boiling. No spontaneous coagulation after 12 hours	
2° Rose	8° S. = 18° D. (approx.)
First stage of acid formation. No precipitation; at most very fine flakes. Coagulates spontaneously after 9½ to 12 hours. Resists boiling 5 to 7 hours	

NORMAL COLOR (WINE RED)	COLOR OF ALCOHOL-ALIZARIN
3° Red brown	9° S. = 20° D.
Acidity has developed. Precipitation in fine or very fine flakes. Resists boiling for 3½ to 5 hours. Coagulates spontaneously after 7½ to 9 hours. If the color is darker and the precipitate more abundant and coarser, mixed lactic and cheese fermentation is indicated. Merchandising value questionable	
4° Brown red	10° S. = 22°D.
Acid formation continued. Fine flaky precipitate. Resists boiling 1½ to 3 hours. Coagulates spontaneously after 6 to 7½ hours. If the color is darker and the precipitate coarser or more abundant, indicates mixed fermentation	
5° Brown	11° S. = 25° D.
Critical state. Precipitate in flakes large and small. Resists boiling ½ to 1 hour. Coagulates spontaneously after 4½ to 6 hours	
6° Brown yellow	12° S. = 27°D.
The milk has reached the limit of resistance to boiling. Precipitation in large or very large flakes. Coagulates on boiling. Spontaneous coagulation after 3 to 4½ hours. Odor acid, but flavor still sweet	
7° Yellow brown	14° S. = 31° D.
The milk has passed the limit of resistance to boiling. Precipitates large flakes. Does not resist boiling. Spontaneous coagulation in 1½ to 3 hours. Odor and taste acid	
8° Yellow	16° S. = 36° D.
The milk has approached spontaneous coagulation. Coagulates in very large flakes. Coagulates on moderate heating. Coagulates spontaneously after 1½ hours as maximum. Odor and taste acid	
9° Red (dark)	7° to 8° S. = 16° to 18° D.
Coagulation: advanced cheesy. Coagulates in very large flakes. Coagulates at first heating and very quickly spontaneously. Taste—sweet. Merchandising value very doubtful	
10° Violet	8° to 9° S. = 18° to 20° D.
Milk called "alkaline." Rich in alkaline salts. Precipitates in very fine flakes. The milk has been neutralized (salted). The constitution is abnormal and improper for consumption as a beverage. Improper for cheese making	

DAIRY NOTES

POISONOUS ACIDS IN CONDENSED MILK

The presence in condensed milk of organic and mineral acids, in excess of the amount which normal fresh milk contains, is conducive to the formation of lumps.

Excessive amounts of acid in condensed milk may be the result of fermentations but usually are due to lack of good sugar, or the use of acid flux in making or sealing of the tin cans. The presence of lumps in milk usually indicates that the milk is either acid or gaseous. The acid curdles the casein in the milk, which is detrimental to the market value of the milk.

The most common channel through which condensed milk becomes contaminated is through the use of zinc chloride as a flux in the making and sealing of the cans. The zinc chloride precedes the solder in the sealing process and some of it is sure to sweat through the seams into the interior of the can, chemically uniting with the casein forming caseinate of zinc, which is highly poisonous. The presence of zinc chloride is noted by a pink or brownish red color of the milk.

In order to avoid the appearance of lumps in condensed milk from this source, cans should be used that are sealed with the flux that is acid free. Dry powdered resin, or resin dissolved in alcohol is harmless in this respect, and is just as effective as the acid fluxes.

ORMA N. SMITH,
Ames, Iowa.

REPORT ON TWO OLD SAMPLES OF BUTTER

Two samples of tinned butter, at least twenty years old, had been kept in the office of the Dairy Commissioner, Ottawa, exposed summer and winter to room temperatures.

Examination on September 16 showed that both tins were in good condition, hermetically sealed and tight. There was no evidence of "swells" or other damage.

No. 1. (*Laboratory No. 74479*). Labelled "Pierre de Bacourt, Dorchester, Que. Extra Finest Canadian Butter." Packed dry in round tin. On opening the tin the butter was found to be soft, with no texture. In appearance it was oleogenous and curdled. Color: light (pale)

yellow: Odor: slightly rancid, but largely yeasty and not very unpleasant. Very disagreeable taste and quite non-edible.

No. 2. (*Laboratory No. 74480*). Labelled "Pure Canadian Butter." Canadian Government Dairy Station, Calgary, Alta. Packed in brine in rectangular tin, in two 1-pound prints, each wrapped in parchment paper. No liquid on opening tin. Very strong rancid odor, slightly aromatic. Very soft, with curdled appearance and no texture. Color: pale yellow; white in spots or patches. Absolutely non-edible.

Analysis

	NUMBER 1	NUMBER 2
Water	14.87	33.60*
Fat	79.75	57.24
Curd	1.42	3.03
Ash†	3.98	6.11
	99.98	100.00
	3.80	5.94

* This includes water absorbed from brine in which the butter was packed.
† Including salt.

Analysis of butter fats

	NUMBER 1	NUMBER 2
Butyro-refractometer at 25°C	48.98	43.44
Iodine No	30.70	31.62
Reickert Meisl No	31.10	25.45
Polenski No	2.03	2.75
Acid No	45.33	121.3
Percentage of free acid in oleic	22.45	60.08
Soluble fatty acids as butyric	5.25	4.11
Insoluble fatty acids	84.93	86.92
Saponification No	227.6	225.8

The refractometer readings are in each case lower than would be expected with normal butters. The lowering of the refractometer indices is explained by the abnormal content of free fatty acids (Lewkowitsch, Vol. I, p. 338).

The iodine numbers are normal.

The lower Reichert Meisl No. and higher Polenski No. for fat No. 2 would seem to indicate conversion of soluble volatile acids into in-

soluble volatile acids in the presence of a large amount of water. This deduction is further supported by the figures obtained for soluble and insoluble fatty acids.

The acid numbers are very high especially in No. 2, and indicate the effect on hydrolysis of glycerides produced by the presence of a large amount of water.

The saponification values are normal.

For comparison the following limits for normal butter are given (Lewkowitsch, Vol. I, p. 338).

Butyro-refractometer at 25°C	49.5–54.0
Iodine No	26.0–35.0
Reichert-Meisl No	24.0–29.4
Polenski No	2.4
Acid No	0.5
Soluble fatty acids as butyric	5.0
Insoluble fatty acids	87.0
Saponification No	224.0

FRANK L. SHUTT,
Dominion Chemist, Department of Agriculture, Ottawa, Canada.

Dairy Bacteriology. PROFESSOR ORLA-JENSEN. Published by J. & A. Churchill, London.

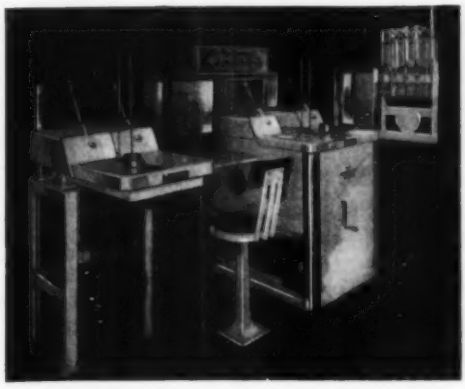
Dr. Orla-Jensen, Professor of Technical Biochemistry in the Polytechnic College, Copenhagen, Denmark, has recently brought out a new addition of his Dairy Bacteriology which has been translated into English. This work is a fine addition to our text-books on Dairy Bacteriology. It aims to make practical application of bacteriological principles to dairy work. It is the outgrowth of the author's twenty-five years experience in bacteriological research.

Among the subjects covered are: Micro-organisms and Fermentations, Bacteria, Yeasts and Moulds, Cleaning and the Procurement of Milk, Preservation of Milk, Application of Lactic Acid Fermentation in the Dairy Industry, Microflora of Butter, The Ripening Processes of the Different Cheeses, The Grading of Milk.

J. H. F.

The Mojonnier Tester

for rapid and accurate butter fat and total solids tests



MOJONNIER MILK TESTER, MODEL D

Process patented April 3, 1917. Apparatus patented February 5, 1918; June 11, 1918; August 5, 1919; March 1st, 1920; March 16, 1920; April 6, 1920; March 21, 1921; September 27, 1921; February 27, 1923

It pays to test your raw materials and finished products accurately.

Every year has seen more Mojonnier Testers being used in the dairy plants of this and foreign countries and the rapidity with which the value of this equipment was appreciated is illustrated graphically below.

MOJONNNIER TESTERS IN USE

The sole reason for this increase has been the fact that the Mojonnier Tester offered the only rapid and accurate method for testing any dairy product for butterfat and total solids enabling the practical immediate use of the results obtained by standardizing the product during processing and production—an economical advantage which invariably paid for the equipment the first year of its operation.

There is a Mojonnier Tester to meet the requirements of any size plant from the plant producing a million gallons of product a year to the plant producing ten thousand gallons a year. The advantages of accurate standardization are the same in any case—a continual saving in dollars and cents and an absolutely uniform product, whether ice cream, evaporated milk, or table cream.

Other Mojonnier Equipment

Mojonnier Ice Cream Packaging Machine
Mojonnier Ice Cream Overrun and Weight Tester
Mojonnier Vacuum Pan
Mojonnier Culture Controller
Several Evaporated Milk Specialties.

Write for further information and prices

Mojonnier Bros. Co.
MILK ENGINEERS
4601 WEST OHIO ST. CHICAGO
SALES BRANCHES:
New York (Elmhurst) Columbus, O.
St. Louis, Mo. Oakland, Calif.

Your advertisement is being read in every State and in 25 Foreign Countries

GUERNSEYS

The Quality--Quantity Breed

The Advanced Register records of the Guernsey breed offer a wide field for research and study.

We find, for instance, that the addition of approximately 2500 records made during 1924, to the 17,000 that existed before January 1, 1924, raises the average production of the breed by over five pounds of butter fat and over 100 pounds of milk.

Information concerning the Guernsey breed is gladly given.

THE AMERICAN GUERNSEY CATTLE CLUB

Box DS **PETERBORO, N. H.**

CHRISTENSEN'S MILK GRADING APPARATUS

FOR

The Reduction and Fermentation Test

This simple and inexpensive method of determing *number* and *kind* of bacteria in milk is bound to be generally adopted.

Our apparatus
"THE MILK GRADER"
has no equal:

Used for either test or the combined test
Temp. Regulation for gas and electricity.
Samples are sufficiently large: 25 cc.
Copper Dipper for collecting the samples.
Tubes may be sterlized in the apparatus.
Water Level is automatically adjusted.

Circulars on Request

OHIO FOOD & DAIRY LABORATORY

VALDEMAR CHRISTENSEN
Chemist and Micro-Biologist

145 East Fourth Street
CINCINNATI, OHIO

The Complete Buttermilk System

CIT-RO-LAC

will build up a business for you

CIT-RO-LAC Buttermilk Sells

Buttermilk with all the good qualities of the natural product combined with the advantages of cultured milk has meant business-building and success for CIT-RO-LAC licensees. This system includes—

Sole license to use the CIT-RO-LAC process and patent and to distribute the product in your territory.

Special CIT-RO-LAC culture, and equipment which will enable you to make and continuously carry a pure culture.

Quick service at all times concerning problems of handling and supervision of equipment.

A proven merchandizing plan that will help to bring quick results.

A production guarantee.

This complete system is worth investigating. We will gladly send you full information.

500 Gallons of Buttermilk or Cream Starter Daily is the production of

THE PETERSEN UNIVERSAL CULTURE CABINET

The Petersen "Universal" is a scientifically correct culture equipment producing dependable and uniform results.

From a Prominent Agricultural College Chemist: "I have had exceptional satisfaction with the Petersen combined sterilizer and incubator. I am using this machine continuously for experimental work on commercial buttermilk and so far, after about two months steady work, I have not had one culture go bad. I believe your machine is an exceptional one, especially in the simplicity of its construction and the ease with which it may be operated. To my mind, such a machine is and should be one of the required pieces of apparatus in every well equipped and up-to-date dairy. We are perfectly satisfied with our machine here at the College."

"Never before have we been able to manufacture a product that was absolutely uniform in flavor and texture as our present buttermilk."

"Saved us over $100 per month. Since using your cabinet we have not found it necessary to buy any culture whatsoever."

"We now have a perfect starter to use in our butter and have also built up an extensive buttermilk trade."

This equipment is sold with our fullest guarantee and at a very low price. Write for full information

CIT-RO-LAC PRODUCTS CO.

MILK ENGINEERING SERVICE

1245 Lawrence Ave. **Chicago, Illinois**

Your advertisement is being read in every State and in 25 Foreign Countries

PROGRESS

As the progress of surgical science has depended upon the discovery and use of antiseptics, so also the progress of dairy science has had to rely upon the discovery of methods and materials able to protect the sensitive qualities of delicate milk foods from deterioration and waste.

Among these methods sanitary cleanliness has proved to be the most essential.

To meet this universal need of better and more dependable dairy sanitation

Wyandotte
Dairyman's
Cleaner and Cleanser

was originated and the convincing proof of its exceptional value is found in the distinctive wholesome and sanitary cleanliness it is providing in a practical and economical way to thousands of dairies the country over.

Indian in circle

in every package.

Order from your supply house

It cleans clean

The J. B. Ford Company, Sole Mnfrs. Wyandotte, Mich.

Your advertisement is being read in every State and in 25 Foreign Countries

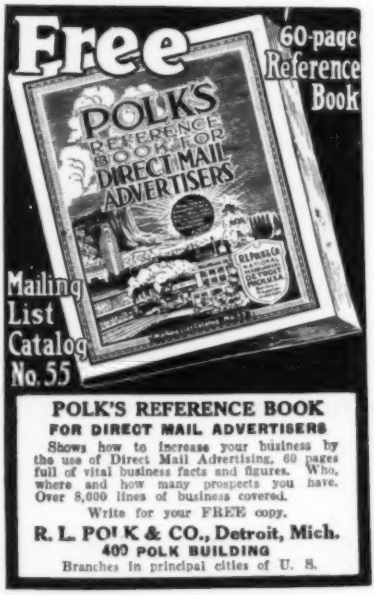
Tycos
TEMPERATURE INSTRUMENTS
INDICATING-RECORDING-CONTROLLING

for
Pasteurizing
use
Tycos
TEMPERATURE RECORDERS

Write for Milk
Plant Catalog
It's free

Taylor Instrument Companies
ROCHESTER, N. Y., U. S. A.

CANADIAN PLANT TYCOS BUILDING, TORONTO
THERE IS A TYCOS OR TAYLOR TEMPERATURE INSTRUMENT FOR EVERY PURPOSE



POLK'S REFERENCE BOOK
FOR DIRECT MAIL ADVERTISERS
Shows how to increase your business by the use of Direct Mail Advertising. 60 pages full of vital business facts and figures. Who, where and how many prospects you have. Over 8,000 lines of business covered.
Write for your FREE copy.
R. L. POLK & CO., Detroit, Mich.
400 POLK BUILDING
Branches in principal cities of U. S.

STANDARD HANSEN'S OF THE WORLD

INVESTIGATE!

A pure rennet enzyme, unadulterated, in handy liquid form, especially prepared and packed for the ice cream trade. That is

HANSEN'S
ICE CREAM RENNET

Its specific action is to increase the viscosity of the mix, thereby increasing the smoothness and apparent richness. It enhances the flavor and makes the desired overrun more uniform and certain.

Make a test and prove to yourself that Hansen's Ice Cream Rennet will do better work, as an improver, at less than one-tenth the usual cost.

Write for free booklet, "Some Ice Cream Problems Solved," by W. W. Fisk, expert in ice cream manufacturing.

Chr. Hansen's Laboratory, Inc.
Little Falls, N. Y.

MILWAUKEE, WIS. TORONTO, CANADA

Your advertisement is being read in every State and in 25 Foreign Countries

MARSCHALL RENNET AND COLOR

STRONG PURE

THE QUALITY OF THE MARSCHALL RENNET-COLOR HAS NEVER BEEN EQUALLED

DEPENDABLE

Made in the largest and best equipped Rennet factory in America!

THE MARSCHALL DAIRY LABORATORY
MADISON WISCONSIN

The Determination of Hydrogen Ions
Wm. Mansfield Clark, Ph.D.
U. S. Hygienic Laboratory, Public Health Service

Recognized as the authoritative text book on hydrogen ion work. Discusses the fundamental theories involved as well as practical applications. A comprehensive bibliography is a feature.

Price, $5.00 net, postpaid.

THE WILLIAMS & WILKINS COMPANY
Publishers of Scientific Books and Periodicals
BALTIMORE, MARYLAND

Wagner's Precision Milk and Cream Test Bottles with **Indestructible Black Graduation**, guaranteed not to decolorize; eye strain is practically eliminated, thereby insuring accuracy, efficiency, and contented operators; the easy reading gives a sense of secureness to the operator, it fortifies him against unjust claims; it makes retesting and rereading unnecessary; saving time and wages.

Some of the testimonials received, read:

"The Wagner Test Bottles with Indestructible Black Graduation are worth their weight in gold."

Order from us or your jobber.

The Wagner Glass Works
ESTABLISHED 1887
Manufacturers and Inventors of Glassware and Apparatus Pertaining to the testing of Milk and its products.

695-697 E. 132nd St.
New York, N. Y.
U. S. A.

BACILAC
DEHYDRATED MILK AGAR

BACTERIOLOGICAL **CULTURE MEDIUM**

BACILAC is dehydrated milk agar

—It eliminates the trouble of preparing milk agar
—It is compounded with tested ingredients
—It is uniform
—It is valuable for differential counts
—It is valuable for growing the Lacto bacillus group
—It produces higher colony counts from milk
—It has been tested in numerous laboratories
—It has been endorsed by authorized committees
—It has passed the experimental stage

AFTER YEARS OF INVESTIGATION AND COMPARISON WITH OTHER STANDARD MEDIA, BACILAC—DEHYDRATED MILK AGAR—IS NOW AVAILABLE FOR GENERAL USE.

MANUFACTURED BY

THE DRY MILK COMPANY

Research Department **15 PARK ROW, NEW YORK**

Your advertisement is being read in every State and in 25 Foreign Countries

DRAWINGS, ARTISTS' WORK AND ENGRAVINGS FOR MEDICAL AND SCIENTIFIC PUBLICATIONS

PUBLISHERS and authors working in the scientific field will be interested in our facilities for producing illustrations for such work. We have had years of experience in working in co-operation with some of the prominent authors and scientists of the Johns Hopkins University, which has developed in our organization an intimate knowledge of the requirements of this particular line of work. We offer you the services of the specialist in this line. Such are not available in every community, and as we are accustomed to working from written instructions, our clientele being largely at distant points, we subconsciously understand the illustrative point to emphasize, and have been very successful in satisfying our most critical patrons.

We will gladly make estimates, submit samples, and co-operate in every way possible in the production of such work.

BALTIMORE MARYLAND
ENGRAVING COMPANY

BALTIMORE, MARYLAND

Your advertisement is being read in every State and in 25 Foreign Countries

K. V. P. Genuine Vegetable Parchment

The Indispensable Insulator

EXPERIMENTAL EVIDENCE

The University of California stored butter for six months with and without Parchment liners, in an experiment involving the use of various types of wood for butter containers.

In this work, described in Bulletin No. 369, butter was packed in containers as follows:

1. Parchment lined and Paraffined.
2. Not Parchment lined and paraffined.
3. Not Parchment lined and not paraffined.

Each month during storage, the butter was scored.

Butter in Parchment lined containers scored highest.

Parchment prevented the taints of the wood flavor from affecting the butter. But that is only part of the story. To quote:

"Storing butter in cubes *without Parchment lining* or in cubes *carelessly lined* will cause objectional flavors *regardless of the wood*."—Bul. No. 369, California Agr. Exp. Station.

KALAMAZOO VEGETABLE PARCHMENT CO., KALAMAZOO, MICH.

Manufacturers of Waxed and Parchment Papers for use on food products.

Let Our Research Department Solve Your Merchandising Problem.

SECOND EDITION

BACTERIOLOGY

By

Conn and Conn

Discussing the History of Bacteriology, the Nature of Microörganisms and their Significance in Connection with Milk Production and Handling; Hygiene; Agriculture and the Industries.

Four chapters devoted to applications of bacteriology in the dairy industry:

Milk Bacteria and Their Activities
Market Problems
The Relation of Milk Bacteria to Public Health
Manufactured Milk Products.

BACTERIOLOGY has already been adopted by thirty colleges as a standard text for classes in Elementary Bacteriology.

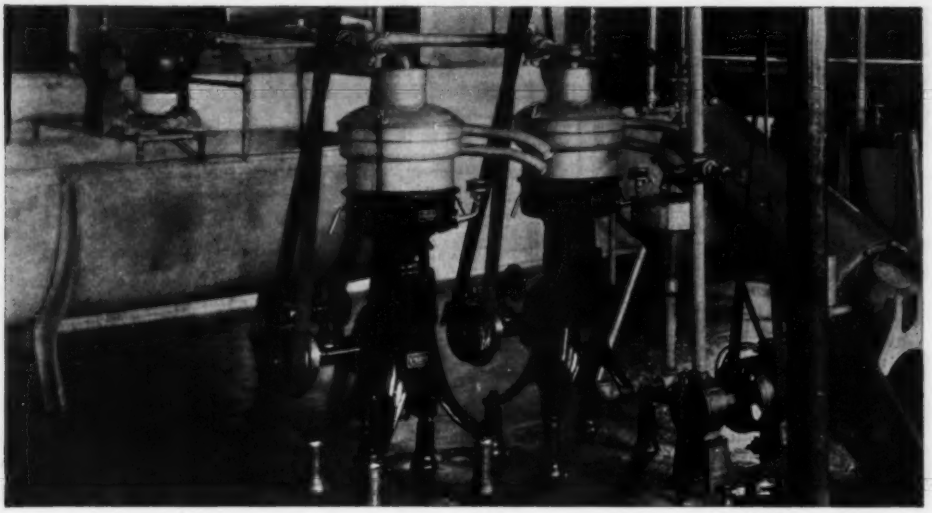
Price $4.00 net, postpaid.

THE WILLIAMS & WILKINS COMPANY

Publishers of Scientific Periodicals and Books

BALTIMORE, MARYLAND

Your advertisement is being read in every State and in 25 Foreign Countries



De Laval Separators in the plant of Plato Dairy Association, Plato, Minn., where A. L. Radke made the butter which won first prize in the Fresh Creamery Class at a recent National Dairy Show.

Quality is helping to increase the consumption of dairy products

Clean milk is the basis of all good dairy products. John Blickenstorfer, of Gratiot, Minn., whose Swiss cheese won first prize at a recent National Dairy Show, says that the best milk he receives is that brought in by Frank Ganshert—a De Laval Milker user. It is almost impossible to produce in any other way milk so clean as that produced with the De Laval Milker.

Even milk so carefully produced can be spoiled for buttermaking by the use of an unsanitary separator or one which breaks up the butter-fat globules. It didn't just happen that the prize winners at each annual convention of the National Creamery Buttermakers Association with but one exception are users of De Laval Separators. Without these machines it would have been almost impossible for them to produce butter of such high quality.

The largest and most successful distributors of whole milk realize the importance of the De Laval Milk Clarifier in removing sediment from their product and making it more desirable from the customer's viewpoint.

Here are three ways in which De Laval machines are working to increase the profits of many concerns producing or distributing dairy products. Are they working for you?

THE DE LAVAL SEPARATOR COMPANY

NEW YORK
165 Broadway

CHICAGO
29 East Madison Street

SAN FRANCISCO
61 Beale Street

Your advertisement is being read in every State and in 25 Foreign Countries

Determination of the Hydrogen Ion Concentration of Milk

THE LAMOTTE HYDROGEN ION TESTING SET
(Model 3B)

RAPID—ACCURATE—SIMPLE

A Single Test May Be Made in One Minute

This set is a complete, portable outfit, especially adapted to the study of the reactions of milk. A few drops only are needed for each test. All necessary reagents and apparatus for the tests are compactly arranged in a mahogany case which may be carried conveniently, thus permitting accurate investigations in the field as well as in the laboratory. Invaluable as an instrument for testing the marketing quality of milk, cream, and other dairy products. Control of milk for infant feeding accurately maintained. Complete directions accompany each set. Descriptive pamphlets sent on request. Price of set complete, $35.00 f. o. b. Baltimore.

LAMOTTE H-ION COMPARATOR SET

A complete outfit containing set of standard tubes and other necessary equipment for determining hydrogen ion concentration.

LAMOTTE STANDARDS

Indicators and Buffer Salts: Specially prepared and standardized Indicator Dyes and Buffer Salts, covering the entire range of pH 1.2–10.0, supplied in dry form or in sterile stock solutions. Standardized in strict accordance with specifications of Clark and Lubs.

Color Standards: Prepared from buffer mixtures and the proper indicators. Supplied in 10cc ampoules for comparator work.

¶ Illustrated catalog containing full information concerning our complete line of "LaMotte Standards" sent on request. Order direct or through your dealer.

THE LAMOTTE CHEMICAL PRODUCTS COMPANY
McCormick Building
BALTIMORE MARYLAND, U. S. A.

THE STANDARD FOR NEARLY FORTY YEARS

TRADE MARK

Paterson Vegetable Parchment

"Nearest to Perfection"

Nearly forty years ago we were making Vegetable Parchment. One does not specialize for nearly forty years without coming very close to Perfection.

The Paterson Parchment Paper Co.

Passaic, New Jersey

DIFCO

BACTO-NUTRIENT AGAR 1%

(Approved)

A dehydrated culture medium prepared especially for milk analysis, containing ingredients in accordance with "Standard Methods" formula, and having a final reaction of pH 6.5-6.6±, is now being supplied at the request of the Committee on "Methods of Bacterial Analysis" of the International Association of Dairy and Milk Inspectors. Each lot is tested by this committee and receives their approval.

Supplied only on orders specifying *Bacto-Nutrient Agar 1% Approved*.

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the research and development of Bacto-Peptone and Dehydrated Culture Media

DIGESTIVE FERMENTS COMPANY

DETROIT, MICHIGAN, U. S. A.